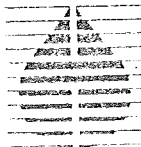


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February 20, 1986

QUALITY ASSURANCE PROJECT PLAN  
ON-SITE GROUNDWATER AND SOILS SAMPLING PLAN  
MONTROSE SITE  
TORRANCE, CALIFORNIA

**REVIEW DRAFT**



HARGIS+ASSOCIATES, INC.  
Consultants in Hydrogeology



HARGIS + ASSOCIATES, INC.

QUALITY ASSURANCE PROJECT PLAN

ON-SITE GROUNDWATER AND SOILS SAMPLING PLAN  
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TORRANCE, CALIFORNIA

February \_\_, 1986

Prepared by  
Hargis + Associates, Inc.  
for  
Montrose Chemical Corporation

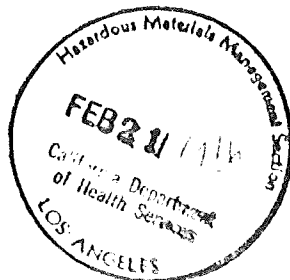
Approved by:

\_\_\_\_\_, QA Project Manager, H+A  
signature date

\_\_\_\_\_, Project/Task Manager, H+A  
signature date

\_\_\_\_\_, Project Officer, USEPA  
signature date

\_\_\_\_\_, QA Officer, USEPA  
signature date





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QUALITY ASSURANCE PROJECT PLAN

ON-SITE GROUNDWATER AND SOILS SAMPLING PLAN  
MONTROSE SITE  
TORRANCE, CALIFORNIA

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## 1.0 INTRODUCTION/OVERVIEW

This Quality Assurance Project Plan (QAPP) has been prepared in accordance with the EPA guidance document "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80", December 29, 1980, for the on-site sampling program for the Montrose site in Torrance, California. Adherence to the quality assurance/quality control program outlined in this document will insure that the data collected are precise, accurate, complete, and representative. Quality assurance is defined as the integrated program designed for assuring reliability of monitoring and measurement data. Quality control is defined as the routine application of standard procedures to obtain prescribed standards of performance in the monitoring and measuring process.

Quality assurance procedures such as tracking, reviewing, and auditing must be implemented to insure that field and laboratory data are of high quality and that all project work is performed in accordance with professional standards, EPA and other governmental regulations and guidelines, and specific project goals and requirements. Outlined in this Quality Assurance Project Plan (QAPP) are the procedures to be followed to insure the quality and reliability of data collected in the study area.

The QAPP covers each of the following activities:

- .. Sample collection, control, chain-of-custody, and analysis.
- .. Required field instruments and sampling equipment, including containers used and methods of sample preservation.
- .. Types of field measurements required.
- .. Site-specific field testing methodology.
- .. Site-specific sampling methodology.



- .. Decontamination procedures.
- .. Data requirements and analytical procedures to be used.
- .. Storage and shipping methods.
- .. Chain-of-custody procedures and document control.

## 2.0 PROJECT DESCRIPTION

The Montrose site occupies about 13 acres in Torrance, California (Figure 1). The area is bounded by Normandie Avenue on the east, Jones Chemical Company on the south, a vacant lot to the west, and the McDonnell-Douglas facility to the north. The surrounding area consists of mixed residential, commercial, and industrial zones. The Del Amo hazardous waste site is located about one-half mile southeast of the Montrose site.

Between 1947 and 1982, Montrose Chemical Corporation operated a DDT manufacturing facility at the site. In 1972, the use of DDT was banned in the United States. The use of DDT was not banned in other countries, and Montrose continued to manufacture and export DDT until 1982 when the facility was closed and completely dismantled. The Montrose site is now capped with asphalt.

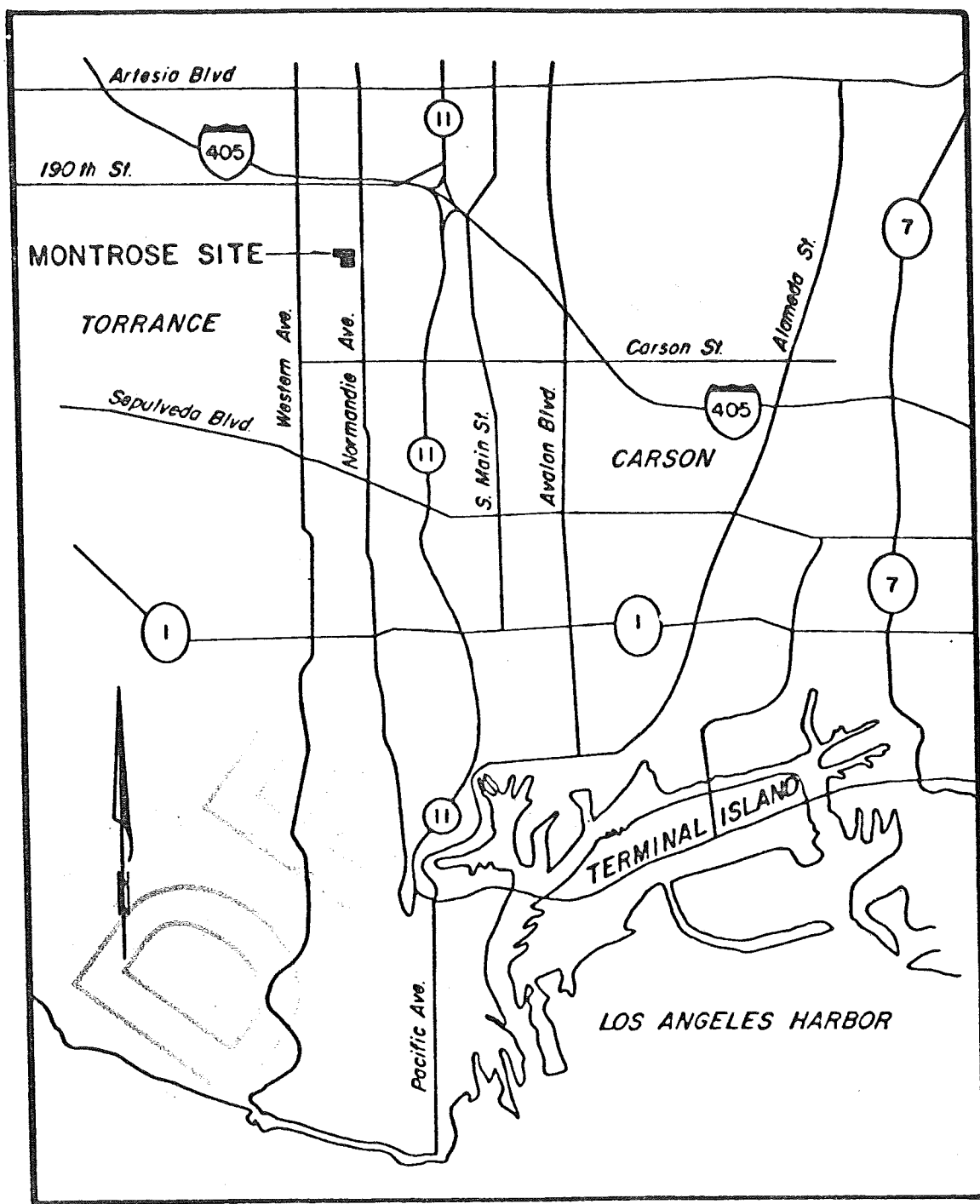


FIGURE I. LOCATION OF MONTROSE SITE



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Previous investigations addressing the potential for contamination at the Montrose site included on- and off-site sampling of soils, groundwater, sediment, and surface water by the U. S. EPA and its contractors, the California Department of Health Services, the Regional Water Quality Control Board, and Hargis + Associates, Inc., acting on behalf of Montrose.

The EPA, through its contractors, Metcalf & Eddy, Inc., conducted an additional on-site soil investigation in June 1985. Results of this investigation are not yet available.

In October 1985, a consent order between the EPA and Montrose was finalized. Tasks outlined in the "EPA Remedial Investigation/Feasibility Study Final Workplan, Montrose Facility Site (Torrance, California), Metcalf & Eddy, Inc., October 1984," as modified by Appendix A of the consent order, are designed to obtain information necessary for the performance of a feasibility study. These tasks include off-site soil, sediment, and surface water sampling, on-site soil sampling, and groundwater monitoring of the Bellflower aquitard, and Gage aquifer. Samples will be analyzed for contaminants designated by EPA as Target Chemicals (Sampling Plan, page 7).

This QAPP addresses only the on-site soil and groundwater tasks. The remedial investigation will be performed for Montrose Chemical Corporation under the direction and supervision of Hargis + Associates, Inc., subject to the review and approval of the EPA. Metcalf & Eddy, Inc., will act as oversight personnel for the EPA.

The objective of the remedial investigation is to further determine the extent of on-site soils and groundwater contamination which may have been caused by activities at the Montrose site, and to gather data of sufficient quantity and quality to support the feasibility study. The sampling will be conducted in phases to allow step-wise evaluation of the analytical results and to provide a basis for determining the number and location of additional sampling points, if necessary.



Phase I sampling will consist of constructing four on-site monitor wells to be completed in the Bellflower aquitard, three on-site monitor wells to be completed in the Gage aquifer, and additional soil borings to be completed in the vicinity of the former impoundment area. Additional on-site Bellflower aquitard monitor wells and an additional Gage aquifer monitor well may be constructed during Phase I, if required.

Groundwater and soil samples collected during Phase I will be analyzed for selected Target Chemicals as identified by the EPA, including DDT and its metabolites DDD and DDE, acetone, benzene, BHC (alpha, beta, delta, and gamma isomers), chlorobenzene, chloroform, 1,2-dichlorobenzene, and 1,4-dichlorobenzene. Groundwater will also be analyzed for common ions for purposes of groundwater characterization. Common ions are listed in Section 5.1, Types, Locations, and Numbers of Samples.

### 3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The proposed Quality Assurance organizational chart for the sampling plan, presented in Figure 2, shows the individuals responsible for each element of the overall program. The key individual responsible for quality assurance is the QA Manager. The QA Manager for this project is Mr. Edward Nemecek of Hargis + Associates, Inc. QA activities are reviewed in biweekly meetings between the QA Manager and the Project/Task Manager. The QA team is responsible for ensuring the collection of valid measurement data and for the routine assessment of measurement systems for precision and accuracy.

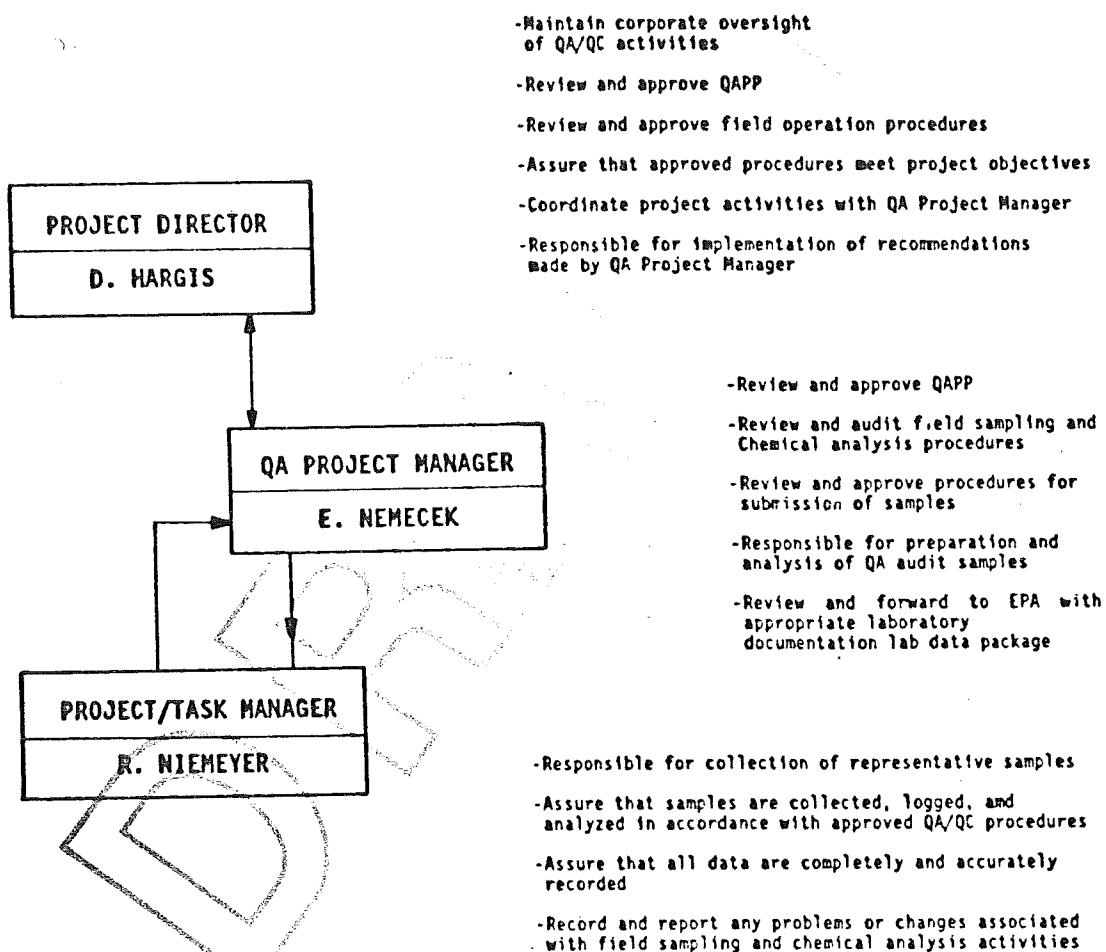


FIGURE 2. QUALITY ASSURANCE ORGANIZATIONAL CHART



#### 4.0 QUALITY ASSURANCE OBJECTIVES

The overall quality assurance objectives are to develop and implement procedures for obtaining and evaluating data that can be used to assess site hazards, aid in developing alternative remedial actions, and be defensible in a court of law. In order to provide defensible data, it is necessary that all measurement data have an appropriate degree of accuracy and reproducibility. All samples collected and all field measurements made must be representative of actual field conditions. Specific quality assurance objectives have been established for accuracy, precision, and completeness of analytic results. Accuracy shall be evaluated in spiked samples in terms of percent recovery; percent recovery shall be within  $\pm 20\%$  of the assumed total analytic concentration. Precision shall be evaluated for duplicate samples in terms of percent difference; percent difference shall be no greater than 20%. Completeness of analytic results will be evaluated by comparing the number of defective results to the number of requested analyses. Measurement completeness, C, shall not be less than 95%. Accuracy, precision, and completeness are defined in Section 14. Methods for determining accuracy, precision, and completeness are also defined in Section 14.

The QAPP presented herein is designed to implement the procedures necessary to maintain consistent quality of data. This consistency will be accomplished through the formal standardization and documentation of field techniques and activities. All field activities will be planned in advance to insure consistency with overall project objectives. Actual field and laboratory activities will be performed by properly trained and qualified personnel and will conform to specific procedures outlined in subsequent sections of the QAPP. Project documents resulting from these activities will be reviewed for completeness, reliability, accuracy, and conformance with specific procedures.



## 5.0 SAMPLING PROCEDURES

Because data collected during Phase I will be used to determine the extent and nature of potential contamination, the procedures presented in this section are designed to insure that all samples obtained are collected in a manner consistent with project objectives, and are identified, preserved, and transported in a manner such that data are representative of the actual site conditions and no information is lost in sample transfer.

### 5.1 Types, Locations, and Numbers of Samples

The types, locations and numbers of samples to be collected are determined based on available data and are specified in the accompanying sample plan. The locations and numbers of proposed groundwater monitor wells and additional soil borings are intended to provide information on the horizontal and vertical distribution of contaminants at the Montrose site.

During the Phase I sampling program, four groundwater monitor wells will be completed in the Bellflower aquitard, and three groundwater monitor wells will be completed in the Gage aquifer at the Montrose site. Proposed well locations are shown in Figure 3. Quality Assurance Procedures for monitor well installation are discussed in Section 5.2.

An initial water sample will be collected from each monitor well after installation. A second water sample will be collected approximately two weeks after the initial sample. Additional samples may be collected, depending on the results of chemical analyses of the first two samples. Detailed methods for sampling groundwater are presented in Section 5.3.1. Site-specific requirements will be outlined in the Sampling Plan.

Soil samples will also be collected from additional soil borings in the vicinity of the former impoundment area. Approximately 48 samples will be obtained from an array of six borings. Detailed methods for sampling

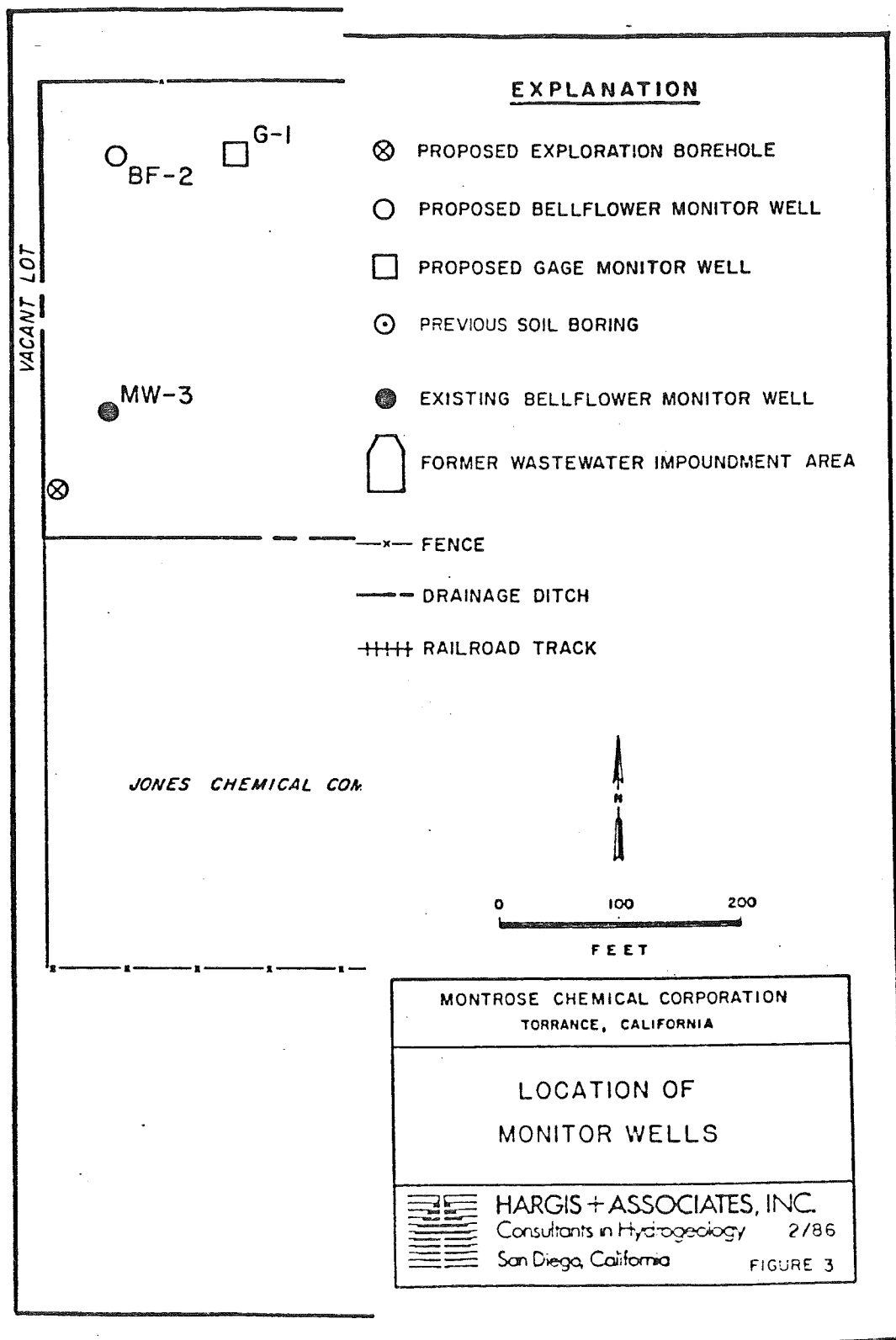


soils are presented in Section 5.3.2. Site-specific requirements are outlined in the Sampling Plan.

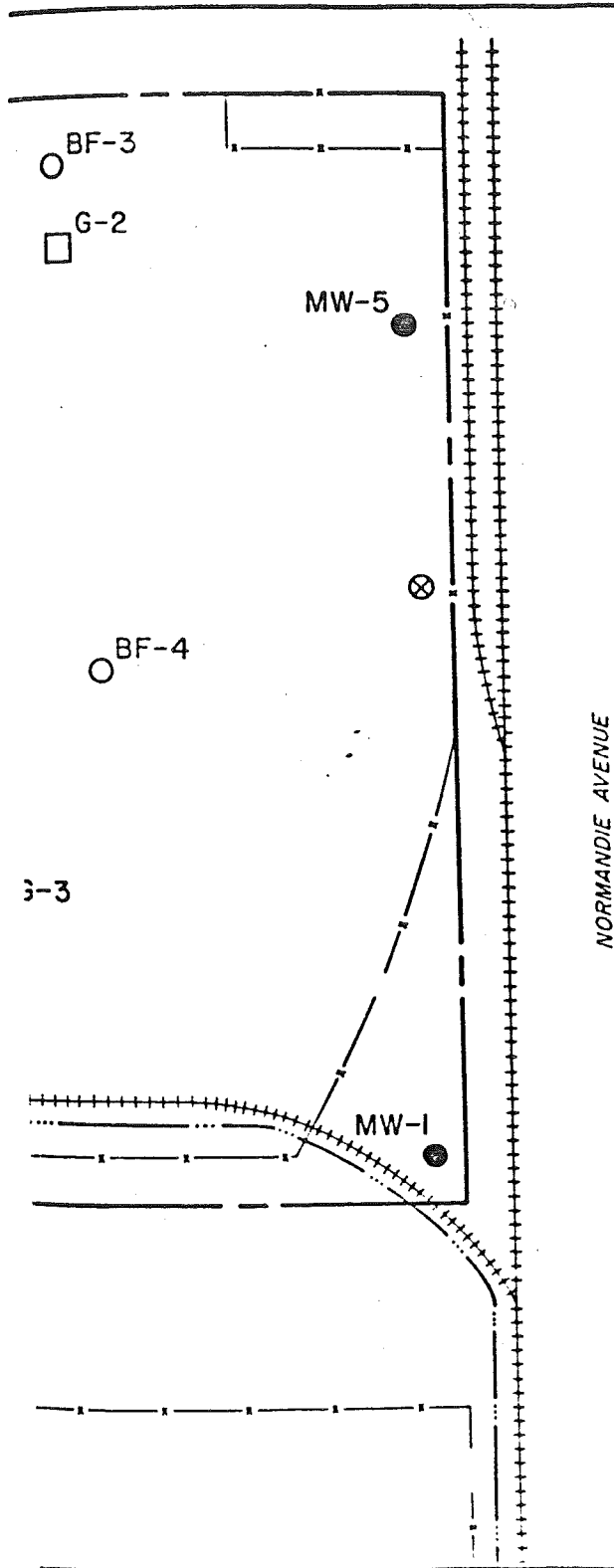
Soil samples and groundwater will be analyzed for DDT and its metabolites DDD and DDE, acetone, benzene, BHC (alpha, beta, delta, gamma isomers), chlorobenzene, chloroform, 1,2-dichlorobenzene, and 1,4-dichlorobenzene. These Target Chemicals were selected by the EPA based on the results of previous on-site investigations conducted both by Hargis + Associates, Inc., and by EPA through its contractor, Metcalf & Eddy, Inc. In addition, the groundwater samples will also be analyzed for the following common ions to assist in differentiating between groundwater from the Bellflower aquitard and groundwater from the Gage aquifer:

Calcium	Carbonate	Nitrate
Magnesium	Bicarbonate	Fluoride
Sodium	Chloride	Boron
Potassium	Sulfate	Silica
Total Dissolved Solids		

The location of each sample will be clearly defined in the Sampling Plan. The sample location and type of sample will be indicated on a site sketch and in a field notebook.

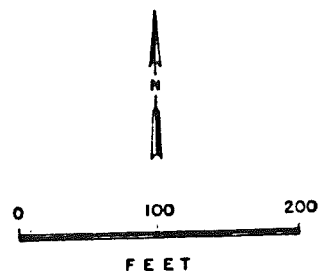






# EXPLANATION

- ⊗ PROPOSED EXPLORATION BOREHOLE
- PROPOSED BELLFLOWER MONITOR WELL
- PROPOSED GAGE MONITOR WELL
- ⊙ PREVIOUS SOIL BORING
- EXISTING BELLFLOWER MONITOR WELL
- ◻ FORMER WASTEWATER IMPOUNDMENT AREA
- x— FENCE
- — — DRAINAGE DITCH
- ++++ RAILROAD TRACK



MONTROSE CHEMICAL CORPORATION  
TORRANCE, CALIFORNIA

## LOCATION OF MONITOR WELLS

HARGIS + ASSOCIATES, INC.  
Consultants in Hydrogeology 2/86  
San Diego, California

FIGURE 3



## 5.2 Monitor Well Installation

The objectives for installing groundwater monitor wells are to further evaluate geologic conditions, the depth and direction of movement of the groundwater, and the chemical quality of the groundwater in the Bellflower aquitard and the Gage aquifer. These objectives will be achieved by conforming to standard operating procedures during well design and construction, geologic logging, water level measurement, sampling, and test activities. Quality assurance depends largely on the field observations made by personnel implementing the standard procedures.

### 5.2.1 Monitor Well Drilling and Construction

Before entering the field to drill and install groundwater monitor wells personnel will prepare detailed well specifications. The specifications will be submitted to qualified drillers. The most qualified bidder will be awarded the drilling contract. A qualified driller will be one who has applicable equipment capabilities, is licensed in the state of California, and who has had experience on similar projects (this shall apply both to the individual driller in the field and to the drilling company as a whole) and appropriate safety training.

Prior to entering the field, personnel will also contact applicable agencies and cities to obtain and comply with regulatory requirements regarding access, drilling, and groundwater extraction.

The monitor wells will be drilled using the hydraulic rotary drilling method. Bentonite drilling muds introduced into the hole must be approved by the on-site geologist prior to use. Measures to limit buildup of "wall cake" in the borehole, including use of fine-grained on-site sediments as natural drilling mud, and circulation of fresh water in the borehole, will be directed by the geologist. Well construction details for the Bellflower

aquitard and the Gage aquifer on-site wells are summarized in Figures 4 and 5, respectively.

The Bellflower aquitard monitor wells will be drilled to an approximate depth of 100 feet. Actual depths of the wells will be determined in the field pending information on geologic conditions. The upper 65 feet of each borehole will be sealed using steel casing cemented in place (Figure 4). Concrete utility vaults with locking lids will be installed at the surface of each well. The wells will be cased with four-inch flush threaded schedule 40 PVC casing. Approximately 30 feet of PVC well screen will be placed at the bottom of the borehole. Each well will be gravel packed to approximately 5 feet above the screen and a bentonite seal will be placed above the gravel pack.

The Gage aquifer monitor wells will initially be drilled to approximately 120 feet to the top of the Gage aquifer. Steel casing will be installed and pressure grouted in place. Cement will be forced down the inside of the casing and up the annulus to land surface during the grouting process. After sufficient time has elapsed to allow the cement to set, the borehole will be advanced until the Gage aquifer has been penetrated to a depth of approximately 145 feet. Fresh water will then be circulated in the borehole to remove any wall cake. Four-inch flush threaded schedule 40 PVC casing will be installed, and approximately 20 feet of PVC screen will be placed at the bottom of the borehole. Each well will be gravel packed to approximately 5 feet above the top of the screen and a bentonite seal will be placed on top of the gravel (Figure 5). Concrete utility vaults with locking lids will be installed at the surface of each well.

The drilling and completion of each monitor well will be overseen by a geologist/hydrogeologist responsible for description of lithology, selection of perforated intervals for screens, and determination of final depth of the well.



Each well will be developed for approximately two hours or until the discharge clears. Discharge rates will be estimated. Recovery of water levels will be measured after well development if possible.

A constant displacement submersible pump will be installed and set above the screened section if sufficient submergence is available. Low capacity submersible pumps may be installed in Bellflower aquitard monitor wells, and pumps will be installed in each Gage aquifer monitor well. Discharge rates of the pumps will be based on discharge rates measured during development. A sounder tube will be installed and strapped alongside the pump discharge pipe for the purpose of measuring the water level. Both the sounder pipe and pump discharge pipe will be fitted with a threaded coupling and plug at the surface to prevent the entry of surface water into the well. The well will be tested following installation for a period of one hour or as otherwise directed by the geologist.

The electrical cable from each pump will be fitted with a plug of appropriate voltage such that all wiring can be stored within the vault.

Following the completion of each phase of monitor well installation, the measuring points of each well will be surveyed to a vertical accuracy of 0.01 feet.





HARGIS ASSOCIATES

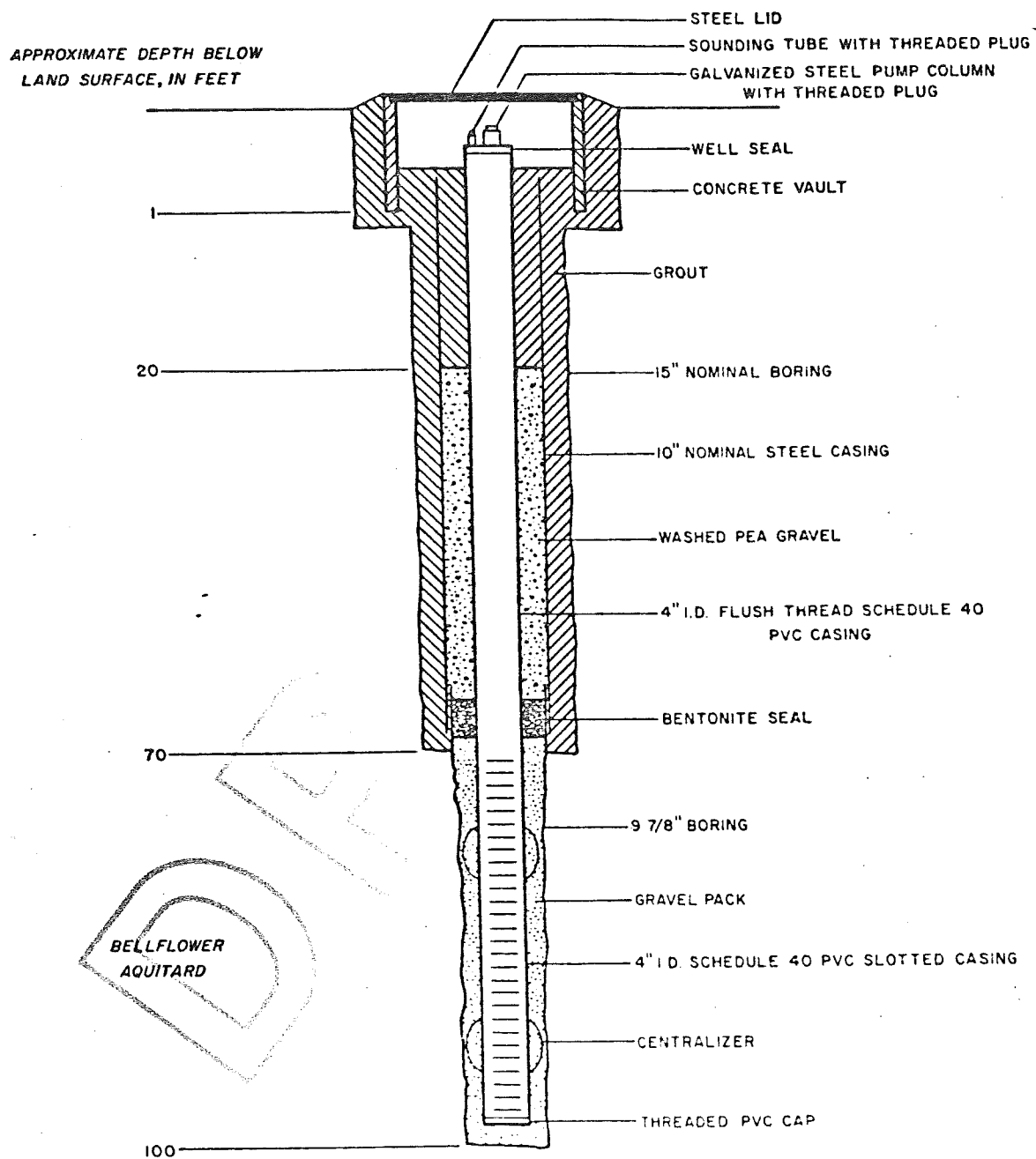


FIGURE 4. BELLFLOWER AQUITARD MONITOR WELL  
CONSTRUCTION DIAGRAM

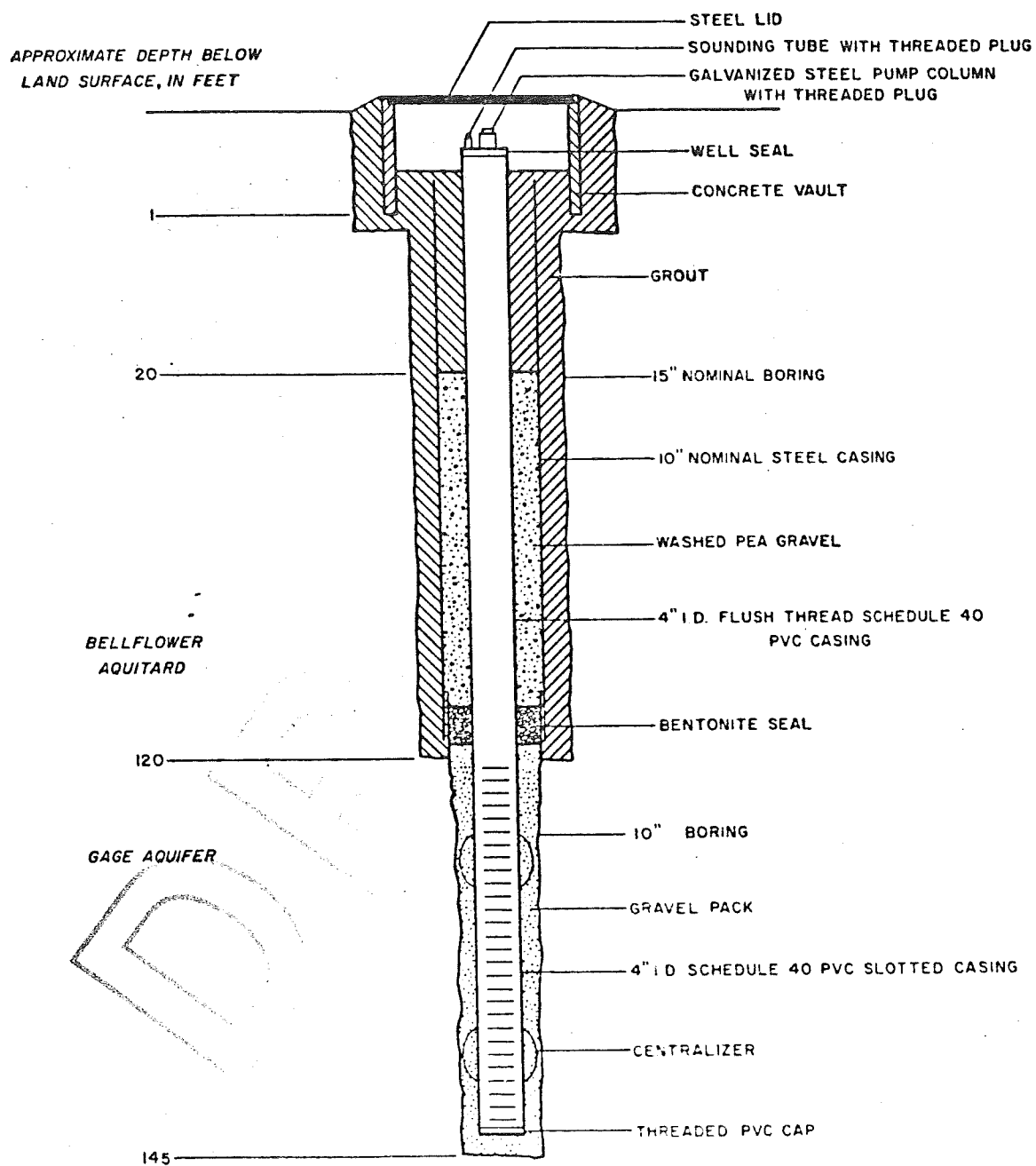


FIGURE 5. GAGE MONITOR WELL CONSTRUCTION DIAGRAM



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### 5.3 Sampling Techniques

Samples collected during Phase I of the remedial investigation include groundwater samples collected from Phase I monitor wells, and soil samples collected from additional borings near the former impoundment area. Specific procedures for collecting groundwater and soil samples are outlined below.

#### 5.3.1 Groundwater Sample Collection

Groundwater samples will be collected from each monitor well installed during the Phase I investigation. A maximum of five borehole volumes of fluid may be removed from the wells by pumping prior to sample collection, if possible within a reasonable length of time. The Bellflower aquitard wells may have to be bailed if they will not produce sufficient volume of water to warrant the use of a submersible pump. The temperature, pH, and specific electrical conductance (EC) of the well discharge will be measured to ensure that these parameters have stabilized prior to collection of samples.

The following procedures will be used to obtain groundwater samples:

#### A. BEFORE ENTERING THE FIELD:

- .. Review project objectives with all personnel and review sampling location, analytical parameters, and time of sampling.
- .. Notify EPA and its contractors for purposes of collecting sample splits.
- .. Review health and safety procedures with all personnel.
- .. Review appropriate permits and site access procedures.



.. Make sure the diameter of the well is known. This will aid in the calculation of the borehole water volume for determining minimum volume to be removed prior to sampling.

.. Determine the total depth of the well. This will enable calculation of the well water volume.

B. IN THE FIELD

.. Record background OVA measurements every three hours.

.. Record daily weather conditions and site characteristics.

.. Measure depth to water.

.. Calculate the borehole water volume for well evacuation purposes (or use a previously prepared table or graph).

.. Pump or bail a minimum of five borehole volumes from each well, or until the field parameters (pH, electrical conductivity, and temperature) have stabilized.

.. Collect water sample in appropriate sample container from the discharge valve at the wellhead or from the PVC bailer after evacuation and stabilization.

.. Record the following information in the field notebook:

.. static depth to groundwater

.. the time that pumping or bailing begins

.. the time of sample collection

.. the pump discharge rate or number of bails

.. the field parameters (pH, electric conductivity, and temperature)



- .. the time that pumping or bailing stops
- .. water level at the time pumping or bailing stops
  
- .. Rinse the sample containers with sample water a minimum of three times to ensure that possible contaminants in the sample bottle are removed. Pretreated sample containers shall not be rinsed with sample water. Bottle preparation is discussed in Section 5.4.1.
  
- .. When sampling for volatile organics, make sure the 40 ml sample vials have no headspace. To avoid aeration, the glass sampler should be held at an angle so that the stream of water flows down the side. Fill the vial until it overflows to eliminate any air bubbles and replace the teflon-lined cap. Two vials should be collected for each sample.
  
- .. Turn the vial upside down and tap it to check for air bubbles. If there are any bubbles, refill the vial and check for air bubbles again. Repeat this procedure until an acceptable sample is obtained.
  
- .. Collect water for pesticides in one-liter amber glass bottles with teflon-lined screw cap lids and for common ions in one-liter polyethylene bottles. Collect water for nitrate analysis in 100-ml polyethylene bottles pretreated with sulfuric acid.
  
- .. Prepare one duplicate sample for every 10 samples collected for each type of sample container.
  
- .. Label each sample container with project number, well number, pre-determined sample number, collector's name and company, and the analyses to be performed (Appendix B-1).



- .. Record all pertinent data concerning each sample in the field notebook.
- .. Prepare letters of transmittal, chain-of-custody documentation (Section 7), and laboratory schedules for analyses to be performed at the end of each sampling event.
- .. Package the sample according to the procedures outlined in Section 5.4.
- .. Prepare one blank water sample of certified organic-free water for each type of sample container included in the shipment.
- .. Place samples on ice as outlined in Section 5.4 and transport to the laboratory by vehicle at the end of each sampling day.
- .. Seal, label, package, and store blank water samples and duplicate samples in a manner identical to the other water samples. The identity of blank water samples and sample duplicates will not be known to the laboratory.

#### 5.3.2 Soil Sample Collection

Soil samples will be collected using split-tube samplers fitted with brass liners. A bucket auger rig will be employed to advance the soil borings and collect the sample. Extracts from the samples obtained at ten-foot intervals will be analyzed immediately for the Target Chemicals. Extracts from the remaining samples will be held until the initial analyses are completed. If further refinement of the chemical character of the soils is necessary, the remaining samples may be analyzed. The following procedure will be used to obtain soil samples:



A. BEFORE ENTERING THE FIELD:

- .. Review project objectives with all personnel and identify sites to be drilled, review sampling locations, sampling equipment and supplies, analytical parameters, and time of sampling.
- .. Notify EPA and its contractors for purposes of collecting sample splits.
- .. Review health and safety procedures with all personnel.
- .. Review appropriate permits and site access procedures.

B. IN THE FIELD:

- .. Cover ground surface around the immediate borehole site with plastic sheeting to prevent mixing of surface and subsurface soil.
- .. Place the three clean 6" brass sample tubes into the sampler body. Assemble the split-tube sampler just prior to the sampling run. Attach sampler to drill rig and drive into the ground.

After the sampler is retrieved, carefully remove the sample tubes. The middle tube will be used for analyses. The other tubes will be used for analyses of splits, duplicates, and if sample recovery from the middle tube is insufficient.

- .. Adjacent sampling tubes will be analyzed as duplicates for one out of every 10 soil samples for each type of analysis.
- .. Record OVA measurements of each sample tube.

- .. Cap ends of sample tubes with teflon liner and plastic end cap. Secure cap with electrical tape.
- .. Prepare background soil sample from a remote location to be included in each sample shipment.
- .. Each sample will be labeled with project number, hole number, depth interval, predetermined sample number, date and time of sampling, collector's name and company, and the analyses to be performed (Appendix B-1). The top and bottom of the sample will be noted on the sample tube. Place each sample in a plastic bag and immediately store in refrigerated chest.
- .. Label, package, and store soil background and duplicate samples in a manner identical with other soil samples. The identity of background and duplicate samples will not be known to the laboratory.
- .. The following information will be entered into a field notebook each time a soil sample is collected:
  - .. hole location and number
  - .. depth interval
  - .. time of sample collection
  - .. OVA readings
  - .. any other pertinent information, including any difficulties in sampling or unusual drilling characteristics.
- .. Decontaminate split-tube sampler by TSP detergent wash, water rinse, and de-ionized water rinse. All wash water will be stored at the Montrose site until results of soil analyses are available. The wash water will be disposed of in an appropriate manner depending on the results of the analyses.





- .. Complete chain-of-custody forms, laboratory analysis schedules, and appropriate transmittal letters (Section 7).
- .. Package samples according to the procedures outlined in Section 5.4 and deliver to the laboratory by vehicle at the end of each sampling day.

#### 5.4 Sample Handling, Packaging, and Shipping

Contained in this section are the required sample handling, packaging, and shipping procedures. These or equivalent procedures will be utilized by the investigative team.

##### 5.4.1 Groundwater Samples

At each monitor well, water samples for analysis of the volatile organic compounds (acetone, benzene, chlorobenzene, chloroform, and dichlorobenzene) will be collected in two 40-ml glass vials equipped with teflon-backed silicon septum screw caps. Correctly prepared bottles and septa are washed with detergent, rinsed with organics-free water, and dried one hour at 105°C. The containers will be rinsed with sample water before the sample is collected.

During sample collection, all vials will be completely filled with water. The teflon liner is placed on the vial in such a manner as to expel any residual air. Zero head space in each VOA vial will be ensured by inverting the vial and gently tapping on the cap. If air bubbles appear the sample will be discarded and the process repeated until zero head space is confirmed.

Water samples for analysis of DDT and its metabolites, and the four isomers of BHC, will be collected in one-liter amber colored glass bottles



sealed with teflon-lined caps. New bottles and liners prepared in the laboratory are rinsed with methylene chloride and dried by vacuum or other safe means until no solvent remains. The glass bottles will be thoroughly rinsed with water bailed or pumped from the wells prior to the collection of the sample.

Water samples for common ion analyses are collected in clean one-liter polyethylene bottles. Water samples for nitrate analysis are collected in 100-ml polyethylene bottles pretreated with sulfuric acid. Containers for all analyses will be cleaned and prepared in the laboratory as specified in the EPA-approved method for each type of analysis. All water samples will be taped, labeled, and stored at 4°C by placing on blue ice in plastic ice chests until the analyses are performed.

Types and sizes of containers to be used, the recommended volume of sample to be collected, sample preservation, container preparation, and maximum laboratory holding time under EPA guidelines for groundwater samples are summarized in Table 1. For each case of samples, a trip blank will be prepared and included with the shipment of field samples. For each sample collected, record the appropriate information in the field notebook and attach the sample labels to each sample container. Prepare laboratory schedules of analyses to be performed and indicate sample concentration and matrix to provide the laboratory with information determining the specific analysis protocols to be followed. For each group of samples, complete all letters of transmittal, chain-of-custody records, and laboratory schedules, pack in a waterproof bag, and include with the samples. Samples must be packed in plastic air bubble packing material to avoid breakage or contamination.

Provisions for split samples from the monitoring wells will be made. EPA and its contractors will be notified prior to commencement of field sampling to allow mobilization of their sampling team and selection of a laboratory. Coordination with EPA and its contractors will be maintained throughout the groundwater sampling process.



#### 5.4.2 Soil Samples

Soil samples for analyses of target chemicals will be collected in brass sampling tubes of the split-tube sampler as outlined in Section 5.3.2. Sampling tubes will be washed in TSP detergent and rinsed with deionized water and chilled on ice before use. Immediately after the sample is taken, the tubes will be capped, labeled, and packed for shipping. Procedures for capping and labeling tubes are described in Section 5.3.2. All sampling tubes will be wrapped individually in plastic bags and placed in an ice chest. The middle tube will be used for all analyses unless sample recovery is insufficient or unless duplicate or split samples are collected. The type and size of container to be used, recommended volume of sample to be collected, preservation techniques, container preparation, and maximum laboratory holding time under EPA guidelines are summarized in Table 1.

TABLE 1  
SAMPLE HANDLING PROTOCOL

TYPE OF ANALYSIS	NUMBER, TYPE, AND SIZE OF CONTAINER	SAMPLE VOLUME	PRESERVATION	MAXIMUM HOLDING TIME	CONTAINER CLEANING
<u>WATER SAMPLES</u>					
Purgeable (Volatile) Organics (EPA Method 624)	Two 40-ml glass vials, tetlon-backed septum	Vials filled completely, no air space	Cool to 40C (in ice chest)	14 days	Bottles and septa washed with detergent, rinsed with organic-free water, and dried one hour at 1050C
Pesticides (EPA method 608)	Two 1-liter amber glass bottles with tetlon-lined caps	Bottles filled 5/6 full	Cool to 40C (in ice chest)	7 days	Bottles and cap liners rinsed with methylene chloride and dried by vacuum or other safe means until no solvent remains.
Common Ions	One 1/2-gallon polyethylene bottle	Bottle filled completely	Cool to 40C (in ice chest)	24 hours	Container washed with detergent and rinsed with distilled water
Nitrate	One 100-ml polyethylene bottle	Bottle filled completely	Preserve sample with sulfuric acid to pH of less than 2; cool to 40C (in ice chest)	24 hours	Container washed with detergent and rinsed with distilled water, pretreated with sulfuric acid
<u>SOIL SAMPLES</u>					
Volatile Organics (EPA method 8240)	One sealed brass tube sleeve with tetlon-lined threaded cap	Sample recovery from side tube	Wrap in plastic bag, cool to 40C (ice in container)	14 days	Sampler washed with TSP detergent and rinsed with deionized water
Pesticides (EPA method 8080)	One sealed brass tube sleeve with tetlon-lined threaded cap	Sample recovery	Wrap in plastic bag, cool to 40C (ice in container)	7 days	Sampler washed with TSP detergent and rinsed with deionized water



For each group of samples, a background soil sample will be prepared and included with the shipment of field samples. For each sample collected, record the appropriate information in the field notebook and attach the sample labels to each sample container. Prepare laboratory schedules of analyses to be performed and indicate sample concentration and matrix to provide the laboratory with information determining the specific analysis protocols to be followed. For each group of samples, pack all corresponding letters of transmittal, chain-of-custody records, and laboratory schedules in a waterproof bag and include with the samples in the shipment. Samples must be packed in plastic air bubble packing material to avoid breakage or contamination.

Split soil samples will be provided to the EPA in the field or at the laboratory. Since true splits of soil samples are not possible, adjoining brass tubes from the split-tube sampler will be provided if sample recovery is sufficient. These samples will be handled, preserved, and stored in a manner identical to the primary sample. Coordination with EPA and its contractors will be maintained throughout the sampling process.

#### 5.5 Sampling Safety and Decontamination Considerations

During drilling and sampling activities in potential source areas, an OVA will be utilized for detection of volatile organic emissions from the borehole. If high readings of volatiles are detected, appropriate safety actions will be taken in accordance with the specifications of the On-Site Safety Plan (On-Site Safety Plan, Montrose Chemical Corporation, 1986). Additional site safety requirements will be specified in the On-Site Safety Plan.

Decontamination procedures for each field event are specified in the Sampling Plan and discussed in Section 5 of this document. Decontamination of personnel and protective equipment and procedures for disposal of



decontamination fluids and drilling cuttings are discussed in the On-Site Safety Plan.

## 6.0 FIELD MEASUREMENTS

This section describes the routine procedures to be followed by all personnel performing field measurements. Sampling activities will include borehole logging, water level measurements, electrical conductivity, temperature, pH, and well discharge measurements. Forms to be used for field measurements are shown in Appendix A.

### 6.1 Borehole Logging

During the drilling of soil borings, a complete log of all conditions encountered during drilling will be maintained. This includes lithologic and hydrogeologic descriptions along with notations on drilling particulars. All logging will be supervised by a qualified geologist.

Major components of the log to be completed are as follows:

- .. At five-foot intervals, the geologist will obtain a sample of the drill cuttings from the split spoon drive sampler. Cutting depth will be noted.
- .. The description of the drill cuttings shall include the following:
  - .. Color of cuttings
  - .. Grain size, shape and sorting
  - .. Moisture content
  - .. Mineral composition
  - .. Descriptive comments, e.g., degree of cementation

- .. Moisture content of all the cuttings will be noted along with the depth at which groundwater is first encountered.
- .. Drilling speed and rig behavior will be noted to help verify the nature of the material encountered by the drill bit.
- .. The on-site geologist will be responsible for writing all the above information on a lithologic log sheet (Appendix A).

Rotary drilling tends to pulverize the coarser fractions of the formation. This consideration will be taken into account when logging a borehole.

## 6.2 Water Level Measurements

Water levels will be measured by an electric sounder or steel tape. The electric sounder used for water level measurements will have marks on the sounder line at regular intervals (one, five, 10, or 25 feet). Each sounder will be accompanied by a calibration log book which will show:

- .. Time and date of last calibration (before entering the field).
- .. The point of calibration (either the center of a mark on the sounding line or along the extreme of the first mark near the probe).
- .. Who did the calibration.
- .. How it was accomplished.

A calibration check will be made in the field by taking a water level measurement with the sounder and checking the measurement with a steel tape. The difference between the two measurements should be less than 0.1 foot per 100 feet of depth to water. These calibration checks will be logged in the calibration log book.



A graduated steel tape will be used for water level measurements when well equipment or hydraulic conditions preclude the use of an electric well sounder. Steel tapes will also be used for quality control checks of electric well sounders. The tapes will be graduated in permanent markings of five-, ten-, 25- or 100-foot intervals.

Steel tapes will be checked for kinks and will have the first five to 10 feet chalked before each measurement.

The following procedures will be used for measuring water levels:

A) BEFORE ENTERING THE FIELD

- .. Identify the wells to be measured.
- .. Identify pumping wells within 1/2 mile of the well to be measured.
- .. Identify established measuring point for a particular well.

B) IN THE FIELD

- .. Sound each well twice for depth to water. The variation must be less than 0.1 foot between the two measurements. When using the steel tape, lower slowly to avoid contact with casing. Once the approximate water level is established, continue making water level measurements until a difference of less than 0.1 foot between measurements is obtained.
- .. If possible, the depth of the well should be measured at the first-time water level measurement. Record measured depth (this will only be applicable to wells that provide access to the well casing without interfering with downhole equipment).





- .. Record the measuring point at the well-head. The same measuring point must be used for subsequent measurements.
- .. Record the distance from the measuring point to the ground level and define "ground level" at that well site, e.g., cement platform, or average ground surface (ground level elevations will be surveyed during initial stages of the Phase I sampling).
- .. Record all information on Water Level Measurement Form (Appendix A).
- .. Remove all equipment and proceed to next well.
- .. Decontaminate equipment by rinsing with distilled water.

### 6.3 Electrical Conductivity, pH, Temperature and Organic Vapor Measurements

A YSI model 33 conductivity meter, a Corning Model 103 pH meter, and a field thermometer will be used for measuring the field parameters, electric conductivity, temperature, and pH in water samples.

The probes on the conductivity meter and pH meter probes will be thoroughly rinsed with distilled water prior to use. Prior to each use the pH meter will be calibrated in pH 4 and pH 10 buffer solutions made up from Hydrion Buffer Chemvelopes. All manufacturer's instructions for use of the instruments will be followed.

A representative water sample will be placed in a nalgene transfer bottle, or measurements will be made directly at the well discharge point. Measurements will be made as follows:

- .. The transfer bottle will be rinsed with sample water prior to filling.

- .. Probes will be immediately submerged in the transfer bottle and measurements will be taken accordingly.
- .. All field measurements will be recorded in a field notebook along with the sample I.D., sample location, and the time and date of measurement.
- .. After parameters are obtained, the transfer bottle and the probe(s) will be decontaminated by rinsing with distilled water. If the transfer bottle cannot be cleaned, a new bottle will be used.
- .. The water sample in the transfer bottle will not be used to fill sample containers.

During all drilling operations, an organic vapor analyzer will be routinely used for detection of volatile organic emissions. Although no significant levels of volatile compounds are expected, the instrument will be employed for safety purposes. If readings of volatiles greater than 10 parts per million above background are detected, or if background concentrations indicate hazardous site conditions, appropriate safety actions will be taken in accordance with the On-Site Safety Plan.

#### 6.4 Well Discharge Measurements

During groundwater quality sampling, field measurements will be made to determine the flow rate of the water discharging from the well. This will be accomplished by different methods depending on the specific well as described below:



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A. WELLS WITH SMALL DISCHARGES

- .. Equipment needed is a five- to 15-gallon container and a stopwatch.
- .. Discharge from the well is directed into the container, and the stopwatch is started.
- .. The stopwatch is turned off when the container is full. This will give the time in minutes and seconds that it took to discharge the volume of water from the well.
- .. Convert the rate of discharge to gallons per minute and record the time this measurement was taken and the rate of flow in gallons per minute.

B. WELLS WITH LARGE DISCHARGES

Well discharge measurements for wells discharging at large rates can be accomplished by using an in-line flow meter or a Cox flow meter. Prior to using either of the above discharge measurement methods, the following must be established:

- .. Well completion details and pump setting specifications.
- .. Pump type, rating, power source, and type of discharge outlet.
- .. The status of adjacent active wells (those within 1/2 mile radius).
- .. Estimates, records, or field measurements of pump discharge, time of pumping, or time since last pumping.



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Once this information is established, one of the above discharge measurement methods may be employed. At the time of measurement, atmospheric conditions or well head conditions which may ultimately affect the discharge measurement should be recorded along with the discharge data. Suggested data forms for this field measurement activity are contained in Appendix A.

Below are brief descriptions of each discharge measurement method which may be used:

A) IN-LINE FLOW METER

If the well is equipped with an operable, in-line flow meter, it will be used to measure well discharge. The meter reading will be compared to a discharge measurement from one of the other acceptable methods to ensure accuracy of the measurement.

The type and manufacturer of the meter will be known prior to operating and reading the meter. Two or more readings will be made until a less than 10 percent difference between readings is obtained.

B) COX FLOW METER

In most situations the Cox flow meter will be used for discharge measurements. It is portable, easily adapted, and accurate to within  $\pm 5$  percent of the actual value.

At any well that the Cox flow meter is used it is necessary that the discharge pipe be full of water. If the pipe cannot be constricted to cause a full pipe, then an alternative flow measurement method is required. The component fittings of the flow meter and discharge pipe adaptation must be airtight. The entire instrument system must also be free of air. At each well where the Cox flow meter is used, two or more readings will be made until a less than 10 percent difference occurs between readings.



## 7.0 SAMPLE CONTROL/CHAIN-OF-CUSTODY

This section describes standard operating procedures for sample identification and chain-of-custody required by EPA contractors and recommended for all RI/FS participants. The purpose of these procedures is to ensure that the quality of the samples is maintained during their collection, transportation, and storage prior to analysis. Alternative procedures are acceptable provided that the quality of the samples is ensured throughout the collection, transportation, and storage process.

### 7.1 Standard Operating Procedures

Sample identification documents must be carefully prepared so that identification and chain-of-custody can be maintained, and sample disposition can be controlled. The sample identification documents that will be used as part of the Phase I investigation are:

- .. Prepared sample labels
- .. Chain-of-custody records
- .. Sample transmittal letters
- .. Field notebooks
- .. Laboratory schedule and analytical services request forms

Examples of sample documents are presented in Appendix B.

Pre-printed and pre-numbered adhesive sample labels must be secured to the sample containers by the sampler. Sample documentation forms and labels are filled out with waterproof ink. Where necessary, the label is protected from water and solvents with clear label protection tape.



Sample documentation forms and labels will include the following information:

- .. Sample Number
- .. Project Code/Case Number
- .. Sample Site Name/Code
- .. Sampling Date
- .. Sampling Personnel
- .. Shipping Method and Date
- .. Sample Description
- .. Sample Matrix and Concentration
- .. Sample Volume and Number of Containers
- .. Sample Destination
- .. Preservatives Used
- .. Analyses Required
- .. Special Handling Procedures
- .. Container Lot Numbers

## 7.2 Chain-of-Custody

Official custody of samples must be maintained and documented from the time of sample collection up to the presentation of analytical results in the final report.

To document sample possession, chain-of-custody procedures are followed as outlined in the sections below. Alternative procedures are acceptable provided that proper custody of the samples is maintained.

### 7.2.1. Field Custody Procedures

Collect only enough samples to provide a good representation of the media being sampled. To the extent possible, the quantity and types of



samples and sample locations are determined before the actual field work. As few people as possible should handle samples.

The field sampler is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly. The Project Manager determines whether proper custody procedures were followed during the field work and decides if additional samples are required.

#### 7.2.2. Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record (Appendix B). When transferring samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer.

Samples are packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate Chain-of-Custody Record accompanying each shipment (one for each field laboratory). Shipping containers will be sealed for shipment to the laboratory. The method of shipment, courier name(s), and other pertinent information are entered in the "Remarks" section of the Chain-of-Custody Record.

All shipments will be accompanied by the Chain-of-Custody Record identifying its contents. Originals and copies will be sent to the appropriate parties, as indicated on the form.

Once received at the laboratory, laboratory custody procedures will apply. However, a separate chain-of-custody record will be prepared for those samples to be split at the laboratory. At that point, it will be the laboratory's responsibility to acknowledge receipt of samples and verify that the containers have not been opened. It is then the laboratory's



responsibility to maintain custody records throughout sample preparation and analysis.

### 7.2.3 Laboratory Custody Procedures

A designated sample custodian accepts custody of the shipped samples and verifies that the information on the Sample Identification number matches that on the Chain-of-Custody Records. Pertinent information as to shipment, pickup, and courier is entered in the "Remarks" section of the Chain-of-Custody Record. Additional laboratory custody procedures are described in Appendix C, Laboratory Quality Control.

### 7.3 Field Notebook

A record of sample identification numbers and chain-of-custody will be maintained in the field notebook. Additionally, it will include a record of significant events, observations, and measurements during field investigations: personnel present, site conditions, drilling procedures, sampling procedures, measurement procedures, and calibration records. Field measurements recorded on standardized forms will be maintained in the project notebook.

All entries will be signed and dated and kept as a permanent record. The information contained in these forms is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the project and to refresh the memory of the field personnel if called upon to give testimony during legal proceedings. Corrections of erroneous entries will be made by crossing a line through the error and entering the correct information. Corrections will be initialed and dated by the person making the entry.





## 8.0 EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE

Field equipment used to perform various measurements during the Phase I investigation will include an electric sounder, steel water level tape, a YSI Model 33 conductivity meter or equivalent for measuring electrical conductivity of water samples, a Corning Model 103 pH meter or equivalent for measuring pH, an organic vapor analyzer, and a field thermometer.

Proper maintenance, calibration, and operation of each instrument will be the responsibility of the field personnel and the lead equipment technician assigned to the project. All instruments and equipment used during the studies will be maintained, calibrated, and operated according to the manufacturer's guidelines and recommendations. At a minimum, all instruments will be inspected and calibrated upon receipt from a vendor or from another office. When in the field, a copy of the manufacturer's operation and calibration recommendations will accompany the instruments. The following guidelines will apply to equipment calibration:

- .. All equipment will be calibrated prior to a field program. This includes instruments used to measure water quality parameters, water levels, well discharge instruments, and air monitoring devices.
- .. The probes on the conductivity meter and pH meter will be rinsed in distilled water prior to each use. Also prior to each use, the pH meter will be calibrated in pH 4 and pH 10 buffer solutions made up from Hydrion Buffer Chemvelopes. The water sample with which pH and electrical conductivity are determined will not be used to fill sample containers. All manufacturer's instructions for use of the instrument will be followed.
- .. For safety purposes, an organic vapor analyzer will be routinely used during all drilling operations for detection of volatile organic emissions. The OVA is factory calibrated. Calibration



checks prior to field use will be conducted according to manufacturer's instructions. The instrument will be sent to the manufacturer for recalibration when indicated by calibration checks or periodically per manufacturer's specifications.

- .. Instruments that require frequent calibration checks, such as an electric sounder or pH meter, will be calibrated daily and after maintenance or repair.
- .. Steel tapes used for well depth measurements should be calibrated twice a year to check for kinks, stretching, or worn markings. Thermometers will be checked against other thermometers prior to field use.
- .. Instruments for which calibration cannot be easily checked will either be tested against another instrument of a similar type or be returned to the manufacturer for appropriate calibration. If tested against another instrument capable of making the same measurements, variation between instruments must not exceed 5%. If readings vary by more than 5%, the instrument should be returned to the manufacturer for calibration.

A routine schedule and record of instrument calibration will be maintained throughout the duration of the study. For instruments that require more frequent calibration, such as an electric sounder, a service manual will accompany the instrument at all times. This will enable the user to document the procedures used in verifying the accuracy of the instrument. For example, the service manual for an electric sounder will include:

- .. The type of marking used on the sounding wire, e.g., tape ferrels, etc.



- .. The distance in feet between each mark and the code to indicate the 100-foot interval.
- .. The date, name of person(s) responsible, changes, or findings of each calibration check, and pertinent modifications made to the sounder, such as adding or removing sounding wire or probes.

Procedures for calibration, operation, and maintenance of laboratory equipment are presented in Appendix C, Laboratory Quality Control.

## 9.0 ANALYTICAL PROCEDURES

All samples collected during this project will be analyzed for the Target Chemicals. Groundwater samples will also be analyzed for common ions for the purpose of differentiating between the water in the Bellflower aquitard and the Gage aquifer. Laboratory analyses will be in accordance with the standard analytical procedures established by the EPA. In general, the laboratory will adhere to those recommendations promulgated in 21 CFR Part 58, "Good Laboratory Practices," and to criteria described in "Methods for Chemical Analysis of Water and Wastes," 1979 (EPA-600/4-79-020).

Target chemicals and common ions in groundwater and soil samples will be analyzed by approved EPA methods. The analytical method and preparation procedures for target chemicals and common ions are summarized in Table 2.

In soil sample preparation, aliquots from the brass sampling tube will be obtained by reaming out the center of each sample after approximately one centimeter of sample from each end of the sleeve has been scraped off.

TABLE 2  
SUMMARY OF ANALYTICAL PROCEDURES

Target Chemicals	EPA Method		Method Preparation
	Water	Soil	
Acetone	624	8240	5030
Benzene	624	8240	5030
BHC (alpha, beta, delta and gamma)	608	8080	3550
Chlorobenzene	624	8240	5030
Chloroform	624	8240	5030
1,2 Dichlorobenzene	624	8240	5030
1,4 Dichlorobenzene	624	8240	5030
DDT, DDD, DDE	608	8080	3550

Common Ion	EPA Method
	Water
Calcium	215.1
Magnesium	242.1
Sodium	273.1
Potassium	258.1
Carbonate	310.1
Bicarbonate	325.2
Chloride	325.2
Sulfate	275.2
Nitrate	353.2
Fluoride	340.2
Boron	Alpha 404 B*
Silica	Alpha 303 C*
Total Dissolved Solids	160.3

\*American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 16th Edition



## 10.0 DATA MANAGEMENT, VALIDATION, AND REPORTING

All raw data generated from project sampling tasks and field measurement activities used in preparing project reports will be appropriately identified and will be included in a separate appendix within the project reports.

### 10.1 Analytical Data

Validation of all analytical data will be performed by the Project Hydrogeologist at Hargis + Associates, Inc. Laboratories will submit results which are supported by sufficient back-up data and QA/QC results to enable the reviewer to determine the quality of the data. Validity of all data will be determined based on the precision and accuracy assessments outlined in Sections 11 and 14. Where test data have been reduced, the method of reduction will be described in the report.

### 10.2 Field Measurement Data

Validation of data obtained from field measurements will be performed by the Project Hydrogeologist. Validity of all data will be determined by checking calibration procedures utilized in the field and by comparing the data to previous measurements obtained at the specific site. Large variations (greater than 10%) will be examined in association with changes in local groundwater conditions and general groundwater trends. Variations in data which cannot be explained by local changes will be assigned a lower level of validity and will be used for limited purposes.

## 11.0 QUALITY CONTROL PROCEDURES

Quality control procedures are specific field and laboratory procedures used to determine accuracy, precision, and completeness of sample data. Quality control procedures for laboratory analysis and field activities, including sample collection and field measurements, are described below.

### 11.1 Laboratory Quality Control Procedures

Laboratory quality control procedures are described in Appendix C, Laboratory Quality Control. Laboratory quality control procedures include the following:

- .. One set of calibration standards, either single point or full range, will be analyzed during each eight hour shift.
- .. One set of reagent and solvent blanks will be analyzed daily.
- .. At least one sample will be analyzed in replicate with each batch of 10 or fewer samples.
- .. At least one spike sample will be analyzed with each batch of samples.
- .. An EPA Quality Control sample or NBS certified sample will be analyzed if available.
- .. Quality Control charts should be maintained.



## 11.2 Field Quality Control Procedures

Quality control of field data obtained during sampling and from measurement equipment will be accomplished by following the guidelines specified in Section 5 and by performing proper calibration procedures at the intervals specified in Section 8. In addition, the quality control methods discussed below shall be implemented.

### 11.2.1 Quality Control Procedures for Sample Collection

Quality control procedures to be conducted during sample collection will include the following:

- .. One duplicate sample will be taken for every 10 samples (or for a set of fewer than 10) at each site per day. The duplicate will not be labeled as such.
- .. One trip blank containing certified organic-free water will be prepared for each type of container and will be included in each sample shipment for analysis.
- .. Split samples will be provided to the EPA according to procedures outlined in Section 5.4.

### 11.2.2 Quality Control Procedures for Field Measurements

#### A. WATER LEVEL MEASUREMENTS

As stated in Section 6.2, water level measurements will be obtained by utilizing either an electric well sounder or a graduated steel tape. Prior to obtaining measurement data, field personnel should check to see that the instrument has been properly calibrated (See Sections 6 and 8).



At each location and/or time interval, a minimum of two measurements should be taken. The most accurate measurement will be determined by the experienced field technician and recorded in the field notebook or on the appropriate field data form. Data should be measured to the nearest 0.1 foot.

In addition to replicate measurements, the data should be compared to previous measurements obtained at the well site. If large discrepancies exist from previous measurements which cannot be explained by local groundwater activities, changes, or trends, the equipment should be recalibrated and the measurements repeated. If possible, an alternative instrument should be utilized to verify the accuracy of the data.

#### B. WATER QUALITY PARAMETERS

Measurements of temperature, pH, and electrical conductance will be performed during each well water sampling event. Prior to obtaining measurement data, field personnel should check to see that the instrument is properly calibrated (see Sections 6 and 8). For pH and electrical conductance, reference solutions can be prepared and should be utilized to properly calibrate the instrument.

When obtaining data for water quality parameters, measurements should be compared with previous data and examined for large variations. If variations greater than  $\pm 10\%$  exist and cannot be accounted for by changes in field conditions and/or water quality stabilization, the instrument should be recalibrated and the measurements repeated. The most accurate measurement will be determined by the experienced field technician and recorded in the field notebooks or on the appropriate field data form. If possible, an alternative measuring device (i.e. another thermometer, pH meter, or electrical conductance meter) should be utilized to verify the data.





### C. DISCHARGE MEASUREMENTS

As stated in Section 6, water well discharge measurements will be obtained during each sampling event. For low output water wells capable of being measured utilizing a properly calibrated bucket, quality control can be achieved by performing at least two measurements in succession to calculate discharge rate. If variations greater than 10% exist between the replicate measurements, additional measurements should be taken. The most accurate measurement will be determined by the experienced field technician and recorded in the field notebook or on the appropriate field data form.

In addition, the data should be compared to previous measurements taken at the well site. If variations between measurements exceed 10% and cannot be accounted for by changes in pumping or groundwater yield, the bucket should be recalibrated and the measurement repeated. If possible, an alternative measurement device should be utilized to verify the data.

Wells with large discharge rates will be measured by one of the methods outlined in Section 6. The most commonly used measurement device will be the Cox flow meter. Quality control will be achieved by performing at least two measurements. If variations between measurements exceed 10%, an additional measurement should be taken. The most accurate measurement will be determined by the experienced field technician and recorded in the field notebook or on the appropriate field data form. When possible, measurements made with the Cox flow meter will be compared to measurements made with in-line flow meters, to verify accuracy.

In addition, the data should be compared to previous measurements taken at the well site. If variations between measurements exceeds 10% and cannot be accounted for by changes in pumping or groundwater yield, the instrument will have to be recalibrated and the measurements repeated. Since the Cox flow meter cannot be calibrated in the field, repeat measurements will have to be performed with an alternative measuring device (see Section 6).

## 12.0 PERFORMANCE AND SYSTEMS AUDITS

The Quality Assurance Manager will monitor and audit the performance of the QA procedures outlined in the QAPP. The Quality Assurance Manager will conduct field and office audits which will ensure that the information being gathered is reliable and of good quality.

### 12.1 Field Audits

The Quality Assurance Manager may schedule audits of field activities at various times to evaluate the execution of sample identification, sample control, chain-of-custody procedures, field documentation, instrument calibration, and field measurement and sampling operation.

Field documents pertaining to sample identification and control will be examined for completeness and accuracy. Field notebooks and field data forms will be reviewed to see that all entries are dated and signed and that the contents are legible, written in ink, and contain accurate and complete documentation of project activities. Because the notebook and field data forms provide the basis for reports written later, they will contain only facts and observations. Language will be objective, factual, and free of personal interpretations or terminology that might prove inappropriate.

The auditor will also check to see that chain-of-custody procedures are being followed and that samples are being kept in custody at all times and are locked to prevent tampering.

Sampling operations will be evaluated to determine if they are performed as stated in the project plan or as directed by the Project Manager. The auditor will check to determine that the appropriate number of samples are being collected, that the samples are being placed in proper containers, and that proper preservation, packaging, and shipment protocols are being followed.



Field measurement activities will be evaluated to determine if they are performed according to guidelines in Sections 6, 8, and 11 of this document. The auditor will spot check various instruments for proper calibration and proper frequency of calibration, and will also check to ensure that the techniques utilized with these instruments are providing accurate data.

## 12.2 Office Audits

Once a field project has been completed, the individual files will be assembled, organized, and securely stored. The documents will be examined to determine whether all necessary items such as signatures, dates, and project codes are included. The auditor will examine all documents and determine whether they are being handled and stored in the proper manner.

In addition to the formal audits performed, the project manager continually reviews product quality as draft documents are produced and ensures that the project is being performed in accordance with approved quality assurance procedures. Prior to the production of a draft report, all work products will receive review by senior project staff. This review will include calculation briefs, test analyses, field measurements, graphs, tables, and any document which involves information generated from the field data.

## 12.3 Laboratory Audits

Laboratory audits are performed quarterly as part of the formal laboratory certification requirement for analyzing public drinking water systems. The laboratory audit is required to monitor the capability and performance of the total measurement system. The audit includes a careful evaluation of equipment, standard operating procedures, and quality control



procedures. Internal laboratory audit procedures are discussed in Appendix C, Laboratory Quality Control.

### 13.0 PREVENTATIVE MAINTENANCE

Preventative maintenance for quality assurance includes those tasks that must be carried out to minimize downtime of the measurement systems. Procedures for preventative maintenance during the Phase I investigation include the following:

- .. Instruments for field measurements will be calibrated and checked before use (Section 8).
- .. Spare parts for instruments such as probes will be on hand in case of equipment failure.
- .. When practical, backup equipment will be available. For example, a steel water level tape will serve as backup for an electric sounder.
- .. Sufficient well construction materials will be on hand to account for monitor well variability as dictated by geologic conditions.
- .. Sampling locations and procedures will be identified and reviewed each day prior to field work.
- .. Two containers for analysis of samples will be collected in case of breakage or contamination.
- .. Additional materials for sample preparation such as containers, caps, and forms will be available on-site.



- .. Laboratory equipment downtime will be minimized by proper calibration and maintenance as discussed in Appendix C.

#### 14.0 DATA ASSESSMENT PROCEDURES

As part of the QA Project Plan, routine procedures will be used to assess the precision, accuracy, and completeness of data for every measurement parameter. In addition, an extensive review of field and analytical data will be conducted to ensure that quality control criteria have been met. Data assessment procedures to evaluate accuracy, precision, and completeness are described below.

##### 14.1 Accuracy

Accuracy is defined as the percent recovery for a spiked sample. A sample spike is prepared by adding a known amount of a pure compound to the environmental sample. The compound added is the same as that being assayed for in the environmental sample. These spikes simulate the background and interferences found in the actual samples; the calculated percent recovery of the spike is taken as a measure of the accuracy of the total analytical method. When there is no change in volume due to the spike, it is calculated as follows:

$$P = \frac{(T-X)}{T} 100 = \text{Percent Recovery}$$

X = Measured value of analyte concentration in the sample before the spike is added

T = Assumed true value of analyte concentration in the sample after the spike is added. Percent recovery must be within  $\pm 20\%$  of the known concentration.



## 14.2 Precision

Precision is defined as the relative percent difference of matrix spike recoveries for two matrix spikes of the same sample (replicates) and is evaluated in terms of the relative percent difference. Because of the limited number of replicate samples that can be analyzed in environmental samples using gas chromatograph techniques, precision cannot be evaluated in terms of standard deviations. Consequently, outlier testing is not possible. However, the precision of an analytical method can be evaluated from internal lab and field duplicates by calculating the percent difference between the duplicate sample results:

$$PD = 2 \frac{(D1-D2)}{(D1+D2)} \times 100$$

PD = Percent Difference

D1 = First Sample Value

D2 = Second Sample Value (duplicated)

The limit for the percent difference between duplicates should not exceed 20%. Since standard deviations cannot be calculated, adherence to standard sampling and analysis procedures will assure that samples are representative.

## 14.3 Completeness

Completeness is described as the ratio of acceptable laboratory results to the total number of analyses requested. A completeness value of less than 95% indicates that corrective action is necessary in order to limit the number of defective results.

Criteria for defective results may include exceeded holding times, percent recoveries greater than 20%, or unsatisfactory supporting data such as dates, locations, or sample identity numbers. An analyses of sample

completeness will be conducted after each sampling round results are returned. Completeness is defined as:

$$C = (1 - \frac{\text{number of defective results}}{\text{total number of requested analysis}}) 100$$

A C value less than 95% will indicate corrective action in order to avoid repeating similar problems in future sampling rounds.

#### 14.4 Assessment

Field data will be assessed by evaluating adherence to guidelines outlined in Sections 5 and 11 for sampling and quality control procedures. Data collected historically in the study areas will be reviewed and used during the investigation. Since such data have been collected by a variety of contractors and agencies using different methods and quality assurance/quality control procedures, judgments as to their quality must be prior to incorporation into investigations.

The kind of data to be used may include water level measurements, chemical data on water and soil, geologic subsurface descriptions, (e.g., drillers' logs) and interpretations of the hydrologic conditions of the study areas.

Each data point used in the investigation that is not collected by Hargis + Associates, Inc., will be evaluated against the QAPP standards for a particular type of data collection. For example, a water level measurement collected during previous investigations at a particular well will be assigned a high level of confidence if the data point is accompanied by information on the type of water level measuring device, the measuring point identification, pumping status of the measured well, construction details of the well, and the general pumping status of adjacent wells; if any of these data should be missing, the recorded, historical water level will be

assigned a lower level of confidence, and may be rejected for the analysis of historical conditions.

Historical chemical data on the nature of soil or water conditions in the study areas will be similarly evaluated against the standards developed in this document. Unless information is available on the method of sample collection, the analytical methods employed, and the quality assurance/quality control procedures used, the data point will be assigned a low level of confidence.

Information on subsurface conditions is usually obtained from drillers' logs. The quality of these logs vary from well to well and from driller to driller. On the basis of field experience in the study areas and review of existing site-specific literature on subsurface conditions, each well log to be used in interpretative evaluations will be subject to judgment by experienced hydrogeologists.

Data collected during the investigation should be collected according to the procedures outlined in this document. Any apparent data collection errors will be identified by evaluation of adherence to the QAPP procedures and evaluation of the data compared to historical trends. If a data point appears to deviate from an anticipated trend, further investigations into the collection methodology and QA/QC procedures will be initiated to resolve questionable data points; pending the conclusion of these evaluations, the data point may either be accepted with a high or low level of confidence or rejected.

#### 15.0 CORRECTIVE ACTION PROCEDURES

Corrective action procedures that might be implemented due to audits resulting in detection of unacceptable data will be developed on a case-by-case basis. Such actions may include altering procedures in the field,





using a different batch of sample containers, increasing calibration and maintenance schedules of field measurement instruments, or recommending an audit of laboratory procedures. The project manager is responsible for initiating the corrective action. The Quality Assurance Manager is responsible for approving the corrective action.

#### 16.0 QUALITY ASSURANCE REPORTS

Interim and Final Remedial Investigation reports will contain separate Quality Assurance sections that summarize data quality information collected during the project. Sampling and field measurement data will be summarized by Hargis + Associates, Inc., using standard formats for sample documentation and reporting. These data, summarized along with the raw data, will be attached to all reports.

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APPENDIX A



HARGIS & ASSOCIATES P.C.

APPENDIX A

FIELD MEASUREMENT FORMS

DR

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HARGIS - ASSOCIATES P.C.

APPENDIX A  
FIELD MEASUREMENT FORMS

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DRAFT



HARGIS ASSOCIATES

A. 1 LITHOLOGIC LOG

DEPTH INTERVAL  
(feet)

DESCRIPTION OF MATERIAL

TOTAL DEPTH OF BOREHOLE:

DRAFT

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## Page \_\_\_\_\_

Measuring Point \_\_\_\_\_  
\_\_\_\_\_ ft. above land surface

Well Location: T\_\_\_\_\_, R\_\_\_\_\_, Sec\_\_\_\_\_

Well Coordinates: \_\_\_\_\_ ft N.Δ

Elevation of Measuring Point \_\_\_\_\_ ft  
above mean sea level.      STATIC WATER LEVEL: \_\_\_\_\_

**BOE-C6-0178632**

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APPENDIX B





HARGIS ASSOCIATES

## APPENDIX B

### SAMPLE CONTROL/CHAIN-OF-CUSTODY DOCUMENTS

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HARGIS - ASSOCIATES, INC.

APPENDIX B  
SAMPLE CONTROL/CHAIN-OF-CUSTODY DOCUMENTS

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DE

B. 1

FIGURE 2. SAMPLE IDENTIFICATION LABEL



HARGIS + ASSOCIATES, INC.  
Consultants in Hydrogeology

2223 Avenida De La Playa Suite 300  
La Jolla, California 92037 (619) 454-0165

Client		Date
Project #	Sample ID	
Initials	Time	
Analyze for		
Preservative/Special Instructions:		

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Project No.		Project Name				NUMBER OF CONTAINERS					REMARKS
Samplers: (Signature)											
Sample Number	Date	Time	Comp	Grab	Station Location						
Relinquished by: (Signature)						Date/Time		Received by: (Signature)			
Relinquished by: (Signature)				Date/Time		Received for Laboratory by: (Signature)			Date/Time		Remarks

## B. 2 CHAIN OF CUSTODY RECORD

HARGIS &amp; ASSOCIATES

B. 3 SAMPLE TRANSMITTAL FORM

**Hargis & Associates, Inc.**  
**CONSULTANTS IN HYDROGEOLOGY**

1735 East Fort Lowell Road, Suite 5

Tucson, Arizona 85719

(602) 881-7300

120371

TOWN and CALDWELL LABORATORIES  
373 S. Fair Oaks Avenue  
Pasadena, California 91105

Attention: Linda Brock or Ed Wilson  
Please call upon Arrival: 681-4655

Job No.: \_\_\_\_\_

Date: \_\_\_\_\_

**ATTENTION:**

Transmitted herewith are \_\_\_\_\_ parcels containing \_\_\_\_\_ soil/water samples. The samples were shipped via \_\_\_\_\_ on the above date. The contents of the sample shipment are shown on the attached Chain-of-Custody Record.

The laboratory representative who accepts custody of these samples from the shipping company should, upon receipt, record the number and condition of the samples and acknowledge receipt of the samples by signing and returning the custody record.

Please perform the analyses outlined on the attached analysis request schedule(s) and include all data on sample labels in the final laboratory report. The date each sample was received by the laboratory and dates of injection, extraction, analysis, etc., should also appear on the laboratory report.

If you have any questions concerning the requested analyses, or if the integrity of a sample(s) is in question, please contact us.

Results of your analyses should be reported to our office as soon as possible.

Very truly yours,

HARGIS & ASSOCIATES



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[illegible]

Calcium	Sodium	Carbonate	Chloride	Nitrate	Boron	TDS	Specific Conductance
Magnesium	Potassium	Bicarbonate	Sulfate	Fluoride	Silica	pH	

Antimony	Beryllium	Chromium (total)	Manganese	Selenium	Zinc
Arsenic	Cadmium	Copper	Mercury	Silver	
Barium	Chromium(VI)	Iron	Nickel	Thallium	
LEAD					

LEAD

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APPENDIX C





HARGIS ASSOCIATES, INC.

## APPENDIX C

### LABORATORY QUALITY CONTROL

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## STATEMENT OF PURPOSE

BROWN and CALDWELL'S Quality Assurance Program is designed to ensure the accuracy and precision of all analytical results. Our philosophy is to provide our clients with service of the highest quality available. Control of analytical results is maintained by adherence to specified operating procedures, use of quality control samples and standards, and observance of sample custody requirements. The purpose of this manual is to describe the basic elements of our overall Quality Assurance program.

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## SECTION I

### DESCRIPTION OF ANALYTICAL SERVICES DIVISION

#### A. Services

Brown and Caldwell's Analytical Services Division has been providing laboratory services to industry and government for over 35 years. Laboratories located at Emeryville in the San Francisco Bay Area and at Pasadena in Greater Los Angeles perform a full range of analytical tests, including the following:

- Compliance monitoring for RCRA, NPDES, CAM, ARB
- Potable water testing
- Water and wastewater characterization
- Toxic and hazardous waste investigation
- Treatability studies
- Analytical consultation and methods development
- Priority Pollutant analysis
- Agricultural pesticide analysis
- Quality control services
- Bacteriology and Microbiology
- Toxicity bioassays
- Sample collection and on-site analysis

#### B. Personnel

The Division is made up of about 70 experienced chemists, biologists, and technical assistants. Half have degrees in chemistry and most of the remainder have other technical degrees. Several staff members hold advanced degrees in their primary field.

In addition to academic preparation, a formal program of training is carried out for new employees or those who change job assignments. A training outline is prepared by the supervisor and discussed with the employee and any senior analysts who may participate in the training. At the end of three months, a technical review is carried out. For this review, the new employee is asked technical questions while the supervisor observes the answers. The review board usually consists of the Technical Director, the Quality Assurance Manager, and the Laboratory Director or Supervisor.

Brown and Caldwell also provides a system for professional development away from the job. Laboratory specialists are frequently sent to training sessions and seminars presented by instrument vendors and professional societies. Does

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reimbursement and tuition reimbursement are available to all employees to maintain and enhance their professional competence. Seminars are regularly presented at each lab by Division staff members and experts from other organizations.

C. Structure

The staff within each laboratory is organized into two primary sections: inorganic and organic (Figure 1). Each section is subdivided into departments having functional responsibilities; each is supervised by a senior analyst.

Each laboratory has a director responsible for verifying all analytical work. The laboratory-wide quality assurance program is headed by a quality assurance manager responsible for monitoring the performance of the laboratories and for taking corrective action as needed. The QA manager reports directly to the vice-president of the Analytical Service Division. He is assisted by a pair of technical directors whose responsibilities include the resolution of technical problems and the documentation of new methods. Each laboratory also maintains a sample control section staffed by a sample control officer and an assistant.

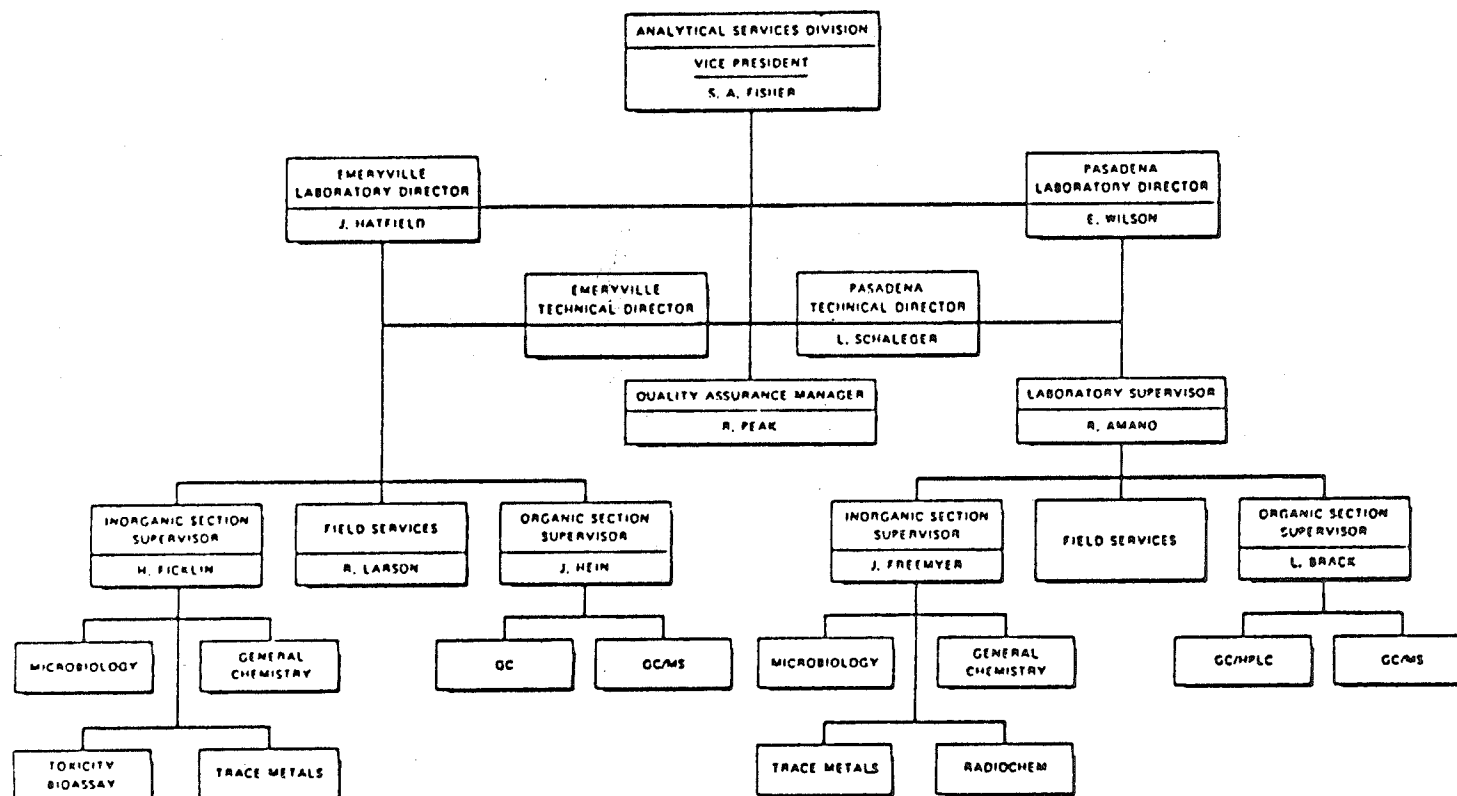


FIGURE 1

BC LABORATORY STAFF ORGANIZATION CHART

## SECTION II

### SAMPLE HANDLING

#### A. Collection

Sampling equipment, appropriate containers and preservatives, and careful monitoring of holding times are a few of the points which must be considered to minimize possibilities for contamination or other threats to the integrity of the sample. Quality assurance begins with experienced field personnel. Sample bottles are clearly marked and all pertinent observations recorded along with the sample description, time, date of collection, and initials of the collector.

To assure proper container selection and appropriate application of preservatives, field personnel and sample control officers are provided with EPA container and preservation guidelines. The rules they follow are contained in Table II of 40 CFR Part 136 (Federal Register, Friday, October 26, 1984). Special containers, such as vials for volatile organics and amber glass bottles pretreated for organic priority pollutant analysis, are purchased from suppliers who provide certificates of compliance with EPA regulations.

#### B. Control and Custody

Verification of sample integrity is one of the main responsibilities of the sample control officer. The sample is inspected to see that:

1. The sample is clearly marked and dated.
2. The sample was collected in an appropriate container for the individual analysis, whether it be glass, plastic, or a special vial to avoid headspace.
3. The sample is properly preserved.
4. There is sufficient volume to do all the analyses required.

If the above conditions are met, the sample will be given a log number and the relevant information is recorded. If

aliquots or subsamples are to be split out, care is taken to ensure that the subsamples are representative of the original. Blending or grinding may be required.

The sample control officer places the sample (or fractions if the sample requires subdivision) into designated storage areas. Most samples are stored under refrigeration at 4 degrees C; refrigerators are marked with test categories for convenient retrieval of samples. Volatile organic vials are segregated from other samples to prevent vapor-phase cross contamination.

Chain-of-custody procedures have been established to document the identity of a sample and its handling from the time of collection until its ultimate disposal. The sampling technician in the field initiates a chain-of-custody record (Figure 2) which is provided with the bottles and remains with the sample throughout its handling. This includes the transfer of samples from the field crew to the laboratory and, in some cases, to the subcontractor's laboratory.

Upon receipt at the laboratory, sample integrity is verified by the sample control officer as described above. Each sample is then assigned a discrete log number which, in addition to being attached to the sample container, is entered on the custody record, in the legally required sample log book, and onto the computerized data handling system. Besides the log number, the computerized record also contains the client name, the sample description, the sample matrix type, the required analytical parameters, and the report due date. Supplementary information such as special handling requirements may be entered as well.



Client name		Job number		<div style="display: flex; justify-content: space-between;"> <div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Analyst required</div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Hazardous sample required</div> </div> <div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Special handling required</div> </div> </div>		Remarks
Project name		Sampler(s)				
Project manager		Sample description		Number of containers		
Sample Number	Date sampled	Type Composite or Grab	Time sampled			
Signature		Company		Date	Time	
Relinquished by						
Received by						
Relinquished by						
Received by						
Relinquished by						
Received by						

BROWN AND CALDWELL Analytical Laboratories  
 1255 Powell Street, Emeryville, CA 94608 (415) 428-2200  
 373 South Fall Oaks Avenue, Pasadena, CA 91105 (213) 681-4655

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

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### SECTION III

#### METHODS

##### A. Sources

Brown and Caldwell makes extensive use of methods prescribed by the USEPA. Other methods are taken from Standard Methods for the Examination of Water and Wastewater, 16th Edition, APHA-AWWA-WPCF, 1985.

Primary USEPA sources of methods for the analysis of aqueous samples include:

Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057, July 1982.

Methods for the Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised, March 1983.

Federal Register, 40 CFR Part 136, October 26, 1984.

Soil and other solid samples are analyzed according to the procedures of Test Methods for Evaluating Solid Waste, USEPA SW-846, July 1982.

A number of additional EPA methods are summarized in the "AB 1803 Methods Manual" issued by the California Department of Health Services, 1984.

Air analysis is based on the NIOSH Manual of Analytical Methods, 2nd and 3rd editions, issued by the National Institute of Occupational Safety and Health of the Public Health Service.

Additional methods for various sample types are taken from such sources as the United States Geological Survey (USGS), the American Society for Testing and Materials (ASTM), and the Association of Official Analytical Chemists (AOAC).

Finally, a number of special methods have been developed by Brown and Caldwell or adapted from literature sources for specialized applications. These methods are written up and maintained in a Brown and Caldwell methods reference manual.

SECTION IV  
FACILITIES AND EQUIPMENT

A. Physical Conditions

The two laboratories which constitute the Analytical Services division contain more than 22,000 square feet of work space. Both are equipped with refrigerated storage areas, fume hoods, central deionized water systems, and general utilities appropriate for modern analytical work. Common equipment such as ovens, incubators, and distillation apparatus are supplemented by specialized instruments described below.

B. Instruments

1. Laboratory Computer System

The multiuser information system is designed for sample and data tracking as well as automatic reporting and invoicing. The two laboratories operate from a shared data base. Hardware includes:

- a. One ADDS Mentor 2500 computer with dual 51 megabyte disc drives and 32 available ports.
- b. Two Micom 8000 twelve-channel multiplexer modems.
- c. Twenty WYSE video display terminals
- d. Two high-speed form printers and three letter-quality printers.

2. Gas Chromatograph/Mass Spectrometers

The three GC/MS instruments include:

- a. Two Finnigan 4000 series GCMS systems interfaced with Nova 4C computers utilizing Winchester 35 megabyte disk drives for data collection. The data system employs Incos computer language. Streamer tape cartridges are used for long-term data storage. GCMS instruments are configured to function in capillary or packed column modes.
- b. One Finnigan 020B GCMS interfaced with a Nova 4C computer utilizing a 10 megabyte Wanco disk drive

for data collection. This data system also employs Incos computer language. A model 10 Perkin Elmer nine-track tape drive is used for long term data storage. The GCMS instrument can be configured in capillary or packed column modes.

- c. Two stand-alone Incos data systems provide extended data-handling and record-keeping capabilities. These systems consist of Nova 4C computers with 10 megabyte Wanco and 35 megabyte Winchester disk drives, respectively.

### 3. Gas Chromatographs

Selective detector gas chromatography is employed to solve a variety of analytical problems in which components of a general chemical class are to be distinguished from background materials not having the class-specific properties. The 12 gas chromatographs currently in use are equipped with a wide variety of detectors, including the following:

- a. Flame ionization detector. Nonselective, used for fuel fingerprinting and odor pattern matching.
- b. Thermal conductivity detector. Nonselective, used for the analysis of methane, carbon dioxide, and other gases.
- c. Electron capture detector. Moderately selective for electron capturing components such as organochlorine pesticides, PCB, and phthalates.
- d. Flame Photometric Detector. Selective for phosphorus or sulfur-containing organics such as organophosphorus pesticides or sulfur gases.
- e. Hall detector. When operated in the halogen mode, highly selective for compounds such as trihalomethanes and chlorinated solvents. It can also be operated in sulfur-selective mode.
- f. Photoionization detector. Selective for photoionizable components such as aromatic solvents, esters and unsaturates.
- g. Thermionic selective detector. Selective for nitrogen- and phosphorus-containing organics such as organophosphorus pesticides and amines.

4. Liquid Chromatograph

Altex model CS4400 liquid chromatograph (LC) is equipped with a microcomputer-controlled solvent gradient system, a multichannel chromatography data system, a variable wavelength UV/VIS detector, and heads for both analytical and preparative scale work.

5. Inductively Coupled Plasma Spectrometer

The Perkin-Elmer Plasma II Inductively coupled plasma spectrometer (ICP) is equipped with a Perkin-Elmer Model 7500 Professional Computer with color graphics for full automation of sample processing and data handling. Supported with a PR 210 dot-matrix color printer, the instrument is capable of determining up to 15 different trace metals in a single analysis.

6. Atomic Absorption Spectrophotometers

The five instruments in current use include Perkin-Elmer models 5000, 2380 (2), 460, and 503 which are equipped to perform flame, graphite furnace, gaseous hydride, and cold vapor analyses. The PE 5000 has a Zeeman background correction system.

7. Ion Chromatographs

A Dionex Model 10 and a Dionex Model QIC are equipped with conductivity and electrochemical detectors. They are employed for multicomponent analysis of anions and cations in complex matrices.

8. Autoanalyzers

An Alpkem Model RFA 300 and a Technicon Model II autoanalyzers are routinely used for nutrient analyses. Manifolds available include NO<sub>2</sub>, NO<sub>3</sub>, PO<sub>4</sub>, Cl, SO<sub>4</sub>, CN, NH<sub>3</sub>, Cr VI, and TKN.

9. Spectrophotometers

The nine spectrophotometers available for routine use include Bausch and Lomb fixed wavelength models, Perkin-Elmer models UV/VIS 283 and 137B IR, and a Coleman model 21 flame photometer.

10. Total Organic Carbon Analyzers

Dohrmann model DC80 and Beckman models 915 and 915B are available. Selection depends on matrix type and concentration.

11. Total Organic Halide (TOX) Analyzers

Xertex (Dohrmann) model DX20 and Oceanographic Instruments model 610 TOX analyzers for RCRA groundwater compliance monitoring are also employed as rapid screening tools for selecting samples for GC or GC/MS analysis of halogenated organics.

12. Radiochemical Counter

Equipment includes an Eberline model MS-3 high voltage supply and an FC-2 internal proportional counter. Auxiliary equipment includes an alpha scintillation counter and special glassware for Radium 226 measurements.

13. Treatability Equipment

The Pasadena laboratory has a 700 square foot area designated for treatability studies. We have a broad array of laboratory scale equipment for evaluating the feasibility of various treatment processes. Equipment available includes biological reactors for activated sludge treatment; ozone generator with column contactors for oxidation treatment; various carbon, mixed-media, sand, and ion exchange columns for filtration/adsorption treatments; and paddle stirrers for flocculation treatment.

14. Bioassay Equipment

Bioassays are conducted in a 200 square foot temperature-controlled environmental chamber. Three 350 gallon aquaria provide large scale holding capacity for acclimation of test species.

Routine equipment maintenance and instrument service is performed on an appropriate service schedule basis. Major instruments such as balances, gas chromatographs, atomic absorption spectrophotometers, and the GC/MS systems are maintained under manufacturer's service contracts or by in-house service technicians. Constant calibration, sensitivity, and response checks on a daily basis establish unscheduled service needs for analytical instruments.

Certain analytical services which are requested on an infrequent basis are maintained at only one laboratory location. This allows us to support the required expertise of that service at a much higher level than would otherwise be possible. Those services maintained in Pasadena are radiochemistry and treatability studies. Emeryville's exclusive services are ion chromatography and fish toxicity bioassays.

C. Reagents and Supplies

Reagent chemicals, purchased from reputable laboratory supply companies, are of ACS reagent grade or better. Calibration standards are either prepared in-house from high purity starting materials or purchased as standard concentrates. Commercial standards are certified by the supplier and are checked on receipt against the previous laboratory standard for the same materials. Carrier gases, solvents, acids and deionized water are checked on a batchwise basis. In this way it is possible to avoid systematic contamination of samples without repeating a set of samples as would be the case if we relied only on method blanks to detect such contamination.

SECTION V  
GENERAL QUALITY CONTROL PRACTICES

A. Blanks

1. Method Blanks

Method blanks are introduced on a daily basis or at a frequency of one-in-twenty if more than that number of determinations are run in one day. The blanks consist of organic-free or deionized water which is then carried through the analytical scheme as for real samples. They serve to locate any contamination associated with laboratory storage, laboratory instrumentation, or equipment coming in contact with the sample during processing. They provide the fundamental baseline against which the sample signal is measured.

2. Field and Travel Blanks

These closely related types of blanks find their most extensive application in analysis for volatile organic compounds. For each kind, the blank begins as organic-free reagent water in the laboratory. For a travel blank, a sample vial is filled with the reagent water at the laboratory and then carried with the sample containers out to the field and back to the laboratory. Field blanks are carried to the sample site in a separate container, with a vial being filled at the sampling location. In either case, the blank serves to identify and possibly correct for airborne contamination associated with collecting or transporting the sample.

3. Sample Blanks

These blanks come into play when native sample characteristics--most often color or turbidity--interfere with a determination. If the method in question relies on spectrophotometric detection, the sample's original absorbance at the wavelength of interest is measured and subtracted from the absorbance of the final developed color. The value is recorded in the bound bench book so both the apparent concentration and the corrected value may be calculated.



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B. Standard Curves

Spectrophotometers are standardized daily with at least three concentrations for every test. Absorbances are recorded in the bound notebook associated with each test; this step permits detection of any change in absolute performance. Indications of declining sensitivity or wavelength inaccuracy are corrected by having the unit professionally serviced.

Gas chromatograph and GC/MS determinations are standardized with three-point curves as described in the October 26, 1984 Federal Register. The curves are verified on a daily basis with a quality control standard.

Standard solutions are prepared at intervals specified in the referenced methods. Where no limit is stated, they are replaced at intervals short enough to prevent detectable deterioration during the lifetime of the material. Even when no deterioration is detected, standards are replaced at least once every six months.

C. Internal Standards and Surrogates

Internal standards are added to concentrated sample extracts of semivolatile priority pollutants and to the purging aliquots of volatile priority pollutant samples. They serve to detect losses during capillary column injection of semivolatiles or during the purging of volatile priority pollutants. They provide a means for applying corrections to individual sample results providing that such losses are not extraordinarily large.

Surrogates are typically spiked into the samples prior to extraction and thereby provide recovery data for sample workup. Although such data are typically derived from compounds closely related to the compounds under investigation, they are not compound-specific and therefore cannot be used for making corrections for recovery. Since the information is provided with every sample, however, it is very useful in detecting both sample-specific and systematic recovery problems.

Surrogates are occasionally used in trace metal analysis as a sample-specific check for recovery problems. We incorporate surrogates into the trace metal quality assurance program only if other evidence shows them to be necessary.

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D. Duplicates and Spikes

Every tenth sample is analyzed in duplicate. The duplicate aliquots are carried through the entire workup and analytical scheme. Care is taken to assure that soils and hazardous wastes are duplicated at least as frequently as waters and wastewaters. How closely the results compare with each other provides a measure of precision for the determination.

The same sample which is duplicated is also subjected to a spike analysis. In this technique, a third aliquot of the sample has added to it a known quantity of the analyte. The recovery on the resulting spiked sample relative to its theoretical value reflects the accuracy of the determination. Since percent recoveries are often strongly influenced by the sample matrix, it is more informative to spike real samples than to spike blanks.

Duplicate results and spike recoveries are sorted by matrix type for statistical analysis and calculation of control charts. If a particular determination is not carried out frequently enough on a particular matrix type for successful statistical manipulation, the results are grouped with others of similar matrices.

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## SECTION VI

### SPECIALIZED QUALITY CONTROL PROCEDURES

#### A. Organics by Gas Chromatography

Specialized quality control procedures for these analyses are typified by those used for Pesticides and PCB's by EPA method 608. For every nine samples analyzed, another three QC samples--a method blank, a duplicate, and a spike--are run. One QC control sample is analyzed for every 100 client samples. The results are compared to the acceptance criteria listed by EPA in the Federal Register. If the result for a particular parameter does not meet the criteria, the sample is reanalyzed for that parameter.

#### B. Organics by GC/MS

##### 1. Volatile Organics; EPA Method 624

For every nine samples analyzed, a method blank, a duplicate, and a spike are also run. Three surrogates are added to each sample in order to monitor purging efficiency and instrument operation. A calibration standard containing a mixture of priority pollutants at the 20 ug/L level is analyzed once each shift.

Each GC/MS instrument is checked and retuned on bromofluorobenzene (BFB) for every shift. One blind QC sample is analyzed for every 100 client samples.

##### 2. Base/Neutral and Acid Extractable Organics; EPA Method 625

Three quality control samples--a method blank, a duplicate, and a spike--are run with every batch of nine samples. Each GC/MS is calibrated daily to ensure that performance on decafluorotriphenyl phosphine (DFTPP) meets EPA criteria. Four surrogates and three internal standards are added to each sample in the batch of 12. A standard containing both base/neutral and acid priority pollutants is analyzed with each set of extracts. A daily sensitivity mixture is run in order to evaluate chromatographic column performance and a blind QC sample is analyzed for every 100 client samples.

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### C. Metals Analysis

Most metals analyses are done by one of three techniques: flame atomic absorption spectrophotometry (FAA), graphite furnace atomic absorption spectrophotometry (GFAA), or inductively coupled argon plasma emission spectrophotometry (ICP). Available supplementary techniques include cold vapor and hydride generation. All sample digestions follow EPA or Standard Methods prescribed procedures. A daily method blank is run for each element. A three-point calibration curve is determined daily for each element. Calibration standards for that curve are prepared by fresh dilution of 1000 mg/L certified standards obtained from commercial sources.

When the concentration of the metal being determined exceeds the highest standard, the sample is diluted so it falls within the range of calibration. A daily laboratory control standard, generally obtained from the USEPA, is run for metals determined by GFAA. The accuracy of the analysis of metals in soils is checked periodically by analyzing a National Bureau of Standards reference material such as SRM #1646, an estuarine sediment.

### D. Selected General Chemistry Procedures

#### 1. Biochemical Oxygen Demand (BOD)

Samples for five-day BOD are stored at 4 degrees C and set within 48 hours of receipt. To test the quality of the dilution water, its dissolved oxygen is measured initially and at the end of the five-day incubation period. Three dilutions of each sample are set. The oxygen depletion of at least one of the dilutions must be at least two mg/L; the final dissolved oxygen content must be greater than one mg/L. One duplicate and one glucose-glutamic acid laboratory control standard are set with each batch of samples. Fresh BOD seed in the form of settled primary effluent from a municipal wastewater treatment facility is obtained weekly. Seed material for analysis of industrial samples is also available.

#### 2. General Mineral Analysis

Several checks on the accuracy of the analysis of drinking water for general minerals are applied. The anion-cation balance must agree to within +/- 3%. Also, the total dissolved solids content should fall within 65 to 75% of the specific conductance.

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E. Microbiology

Certification requirements of the California Department of Health Services control the principal features of microbiology QC. These features include daily recording of all incubator temperatures, recording and filing of the autoclave performance record, sterilization of sample containers, application of a dechlorinating agent to sample containers, and monthly performance of a completed coliform test to verify routine confirmed coliform results.

An annual water suitability test is run to make sure the purified water used in media preparation contains no growth promoting or inhibitory substances. An inhibitory residue test is carried out annually on glassware to verify that routine cleaning procedures will not adversely affect results.

F. Fish Bioassay

Fish toxicity bioassays are carried out according to California Department of Fish and Game Guidelines, using specified test organisms, sample dilutions, and sample volumes. They are conducted in a constant temperature room in which fish are acclimated for seven days prior to use in tests. Checks performed before and during tests on the control tank and on all dilutions are pH, temperature, and dissolved oxygen level. Freshwater bioassays are checked for alkalinity and hardness while saline or brackish bioassays are checked for conductivity at the beginning of the test. A test is considered invalid if there is more than 10% mortality among control fish during the test. Temperatures of test solutions must be within the specified test range for the organism used. Dissolved oxygen must not fall below 70% saturation. Confidence limits are established using the Lichfield-Wilcoxon method of evaluating dose-effect experiments.

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## SECTION VII

### PERFORMANCE AUDITS

#### A. Laboratory Control Standards and Check Samples

Certified reference materials are acquired from the National Bureau of Standards for metals in tissue and sediment-like matrices. EPA provides performance evaluation standards for both metals and organics. Additional certified reference materials are provided by the American Industrial Hygiene Association as part of their laboratory certification program. Using them as laboratory control standards, our laboratories analyze these materials on a regular basis. This measure is particularly valuable in determining accuracy.

Additional reference materials are provided through laboratory exchange of standards. At least once every six months, upon preparation or purchase of a new calibration standard, each of the two Analytical Services Division laboratories sends a portion of the standard to the other laboratory. This program assures that at least four times per year both laboratories analyze exactly the same standard solution for every test. Any disagreements are resolved before the new standard is put into service.

#### B. Certification Programs

The laboratories are subjected to performance audits initiated several times every year. Recent audits have included:

1. USEPA semiannual drinking water performance check samples (WS series).
2. USEPA semiannual wastewater performance check samples (WP series).
3. California Department of Health Services (DOHS) certification for the analysis of priority pollutants and agricultural pesticides in well water, 1984.
4. Arizona Department of Health Services certification for the analysis of Title 22 parameters and fumigants (EDB, DBCP) in drinking water.

5. Orange County Environmental Management Agency approval to analyze for metals, inorganics, halogenated pesticides and PCBs.
6. Submittal of applications and analysis of check samples for California DOHS certification for complete chemical analysis of hazardous wastes.

C. Brown and Caldwell Interlaboratory Comparisons

The exchange of samples between laboratories is a widely recognized quality assurance measure which provides information about procedural errors, contamination unique to a particular laboratory, and interlaboratory precision and accuracy. Since the Analytical Services Division consists of two independently operated but similarly equipped laboratories, interlaboratory studies may be carried out with particular convenience. In this way one laboratory can serve as the external quality assurance unit for the other.

The Sample Control Officer of each laboratory is in charge of splitting samples for such comparative purposes. Except for the exchange of standard solutions described earlier, the interlaboratory exchange program is usually reserved for major projects with special QA/QC requirements.

D. Round Robin Studies

The Brown and Caldwell laboratories frequently participate in studies of methods or performance among groups of well-qualified environmental laboratories. Samples for such studies have been provided by Los Angeles County Sanitation Districts, Orange County Sanitation Districts, Electric Power Research Institute, and other public agencies and trade associations.

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## SECTION VIII

### DATA HANDLING AND ASSESSMENT

#### A. Computer Management

The laboratory utilizes a computerized sample control and data management system for collecting and reporting analytical data. Upon receipt, a sample is logged into the computer to initiate the process. Associated with each sample is a unique log number, client sample description, sample matrix type, the required analytical parameters, and due date. Also included is supplementary information such as special handling requirements.

The next morning, each section supervisor receives a packet of computer-generated work sheets listing work in house arranged according to analytical parameter and due date. The sheets listing groups of samples are then distributed to the appropriate chemists. The chemist performs the necessary analysis and records the raw data in a permanently bound notebook. Calculations are carried out on a hand-held calculator and the final result is entered by hand into the appropriate blank on the computer work sheet.

That evening, the data input operator enters the day's results into the computer where they are transferred to "work awaiting approval" (WAA) status. The next morning the computer prints the previously entered results on work sheets which each analyst checks against the original data as recorded in the analytical notebook for that parameter. The analyst initials the entry to signify approval or can make corrections if necessary.

Later that day the initials are entered into the computer, which then transfers the data to the "report" file. When all the results for a particular sample have been entered and approved, a final report is printed. The printed report is reviewed by the section supervisor and signed by the Laboratory Director before being mailed to the client.

This computerized system maintains a complete audit trail for the work done on each sample. Information such as date sampled, date received, analyst's name, date completed, and the analytical method used in each determination are all retrievable from the data base.

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B. Archiving

Organic sample concentrates are sorted by project, clearly labeled and stored in a freezer for future reanalysis. Therefore, if methodological advances, changes in scope, or evidence of instrument malfunction are developed following analysis, complete reprocessing of the sample is not necessary. Where applicable, it is more convenient to ship concentrates than to ship samples. Properly applied, this measure provides a means to detect systematic errors.

Following analysis, all samples are kept for a minimum of 30 days. In this way, questions raised during the review of data can be addressed by inspection of the sample or by complete reanalysis using a different method. Analysis for components subsequently added to the list of parameters to be measured and incompatible with previous sample workup may be analyzed without resampling. The chief quality assurance feature provided by the archived samples is the ability to use the archived samples to resolve problems which may be noted only as the data are compared and interpreted.

Raw data for most procedures are kept in bound notebooks associated with the test or group of determinations. The completed notebooks are filed in the laboratory for ready reference should future comparisons be desirable. Raw chromatographic data, such as that collected in the quantitation of trace organics, are filed to permit critical reexamination at any time. Such information is particularly useful in cases where the inspection of old data may yield clues regarding the presence of newly identified species.

Raw GC/MS chromatograms are similarly archived together with the spectra of chromatographically isolated but unidentified components. In addition, raw GC/MS data are transferred to tape in an EPA-approved format in order to permit reprocessing to retroactively search for new classes of compounds or otherwise reexamine previously reported findings.

In addition to computer storage, a hard-copy printout of every sample report is filed under the client's name and saved for five years.

C. Detection Limits

The method detection limit is often defined as the minimum concentration of analyte which can be identified, measured,

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and reported with 99 percent confidence that the concentration is greater than zero. It is determined from the analysis of the analyte in question in the appropriate matrix. The procedure for establishing the method detection limit is provided in Appendix B of 40 CFR Part 136 as published in the Federal Register of October 26, 1984. Appropriate use of detection limits minimizes confusion in subsequent use of the data.

In general, the protocol for determination of the method detection limit is too laborious to permit its routine application in the laboratory. Instead, the "estimated detection limit" is determined on a daily basis by any one of the several approaches cited in the above reference. It should be noted that detection limits, no matter how estimated, are highly variable. They depend on the instrument, the analyst, reagent purity, and other factors. In many instances, the detection limit will be dictated by the nature of interferences present in the sample matrix rather than instrumental considerations.

#### D. Assessment

Before the significance of analytical data can be assessed, one needs to know how precise, how accurate, and how complete are the data subsets. Precision is amenable to strict definition by the analysis of replicate results according to schemes outlined in the USEPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories, March, 1979, Chapter 6. Accuracy is somewhat more difficult to assess. Spike recovery determinations, regular analysis of laboratory control standards, and use of external check samples contribute to the general assurance that the accuracy of a determination is within acceptable limits. The ultimate accuracy of a determination also depends on factors external to the laboratory such as sampling and storage conditions. Completeness is the most difficult characteristic to assess, depending as it does upon such factors as representativeness of sampling and subsampling, selection of the appropriate analytical parameters, and scope of the sampling program relative to the size of the environmental question being addressed.

While ultimate assessment depends on the experienced judgment of knowledgeable individuals, statistical treatment of the data can provide some objective measure of their soundness. The Federal Register of October 26, 1984, includes required calculations for accuracy on spiked

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samples for several organics methods. The same calculation may be used for any test amenable to spiking:

$$P = 100(A - B)/T$$

Where:

P = Percent spike recovery  
A = Concentration determined on spiked sample  
B = Concentration determined on original unspiked sample  
T = True value of spike added

Precision values may be calculated from analysis of duplicate pairs. In his manual Quality Assurance of Chemical Measurements, John K. Taylor of the National Bureau of Standards provides a formula for calculating the standard deviation based on a series of duplicates. When a sufficient number of spiked samples or duplicate pairs (at least 20) have been analyzed, control charts may be calculated. Because of the wide diversity of sample types and many different determinations, control charts have usually been calculated only in connection with special programs requiring them. However, the laboratory computer system is now being programmed to calculate and maintain charts for every test on every type of sample. For accuracy, the mean recovery and standard deviation (S) are calculated. Warning limits are set at +/- 2S and control limits at +/- 3S. For precision, since the least difference between a pair of duplicates is zero, that value forms the baseline of the chart. The standard deviation provides upper limits, with the warning limit set at 2S and the control limit at 3S.

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## SECTION IX

### CORRECTIVE ACTION

The control chart, predetermined acceptance limit, or EPA acceptance criteria serve as alert systems for unsatisfactory or unexpected results. The nature of corrective action may take several forms, but the first step is usually to repeat the analysis on the sample which failed. If the repeat does not replicate the failure, and prior and subsequent QC data do not indicate a systematic error, the value may be treated as a random error and disregarded.

More commonly, diagnosis and correction of an analytical problem will follow. If the repeat analysis continues to show difficulty, the analyst will bring it to the section supervisor's attention. If the required correction is not readily apparent, the supervisor will call in the laboratory technical director and the quality assurance manager. Together, they plan a series of steps to isolate and correct the problem. Based on frequency of occurrence and correctability, the usual checking order includes:

1. Check the calculations.
2. Examine the sample for non-homogeneity or peculiar interferences.
3. Restandardize any titrating agents used in the test.
4. Check instruments for proper performance.
5. Verify that standard solutions are fresh and properly prepared.
6. Assure the purity of reagent water.
7. Closely observe the analyst to be certain no procedural errors are occurring.

During the troubleshooting process, routine analysis for that determination is discontinued. Once the problem is found and corrected, the best estimate is made of when the problem first occurred. Data collected after this critical point is discarded. If possible, all analyses since the last valid control check will be repeated. Analyses performed after the resolution of the problem must be accompanied by more

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duplicates and spikes than the regular ten percent level. The higher level of QC continues until the section supervisor and the quality assurance manager are satisfied that the problem has been completely solved.

To assist efficient resolution of problems, the QA manager maintains a test-based file of previous corrective actions. The material is readily available to both laboratories. Since some determinations may be subject to common errors, this program helps reduce the time required to correct a problem if the other Division laboratory has previously dealt with the same issue.

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B. Examples

A listing of methods used by Brown and Caldwell for priority pollutant analysis in aqueous samples and solid wastes is given in Table 1. Also included are methods for hazardous waste analysis.

TABLE 1

METHODS FOR PRIORITY POLLUTANT AND HAZARDOUS WASTE ANALYSIS

<u>Determination</u>	<u>EPA Method Number</u>	
	<u>Water</u>	<u>Soil, Waste</u>
Volatile organics by GC/MS	624	8240
Semivolatile organics by GC/MS	625	8270
Organochlorine pesticides and PCB's by GC/ECD	608	8080
Cyanide	335.3	9010
Phenolics, total	420.1	9065
Antimony	204.2	7041
Arsenic	206.2	7060
Beryllium	210.2	7091
Cadmium	213.2	7131
Chromium	218.2	7191
Hexavalent Chromium	218.5	7196
Copper	220.2	7211
Lead	239.2	7421
Mercury	245.1	7471
Nickel	249.2	7521
Selenium	270.3	7740
Silver	272.2	7761
Thallium	279.2	7841
Zinc	289.2	7950
Ignitability	----	1010
EP Toxicity	----	1310
Chlorophenoxy Herbicides	8150	8150

Note: GC/MS is Gas Chromatography/Mass Spectrometry and GC/ECD is Gas Chromatography with Electron Capture Detection.